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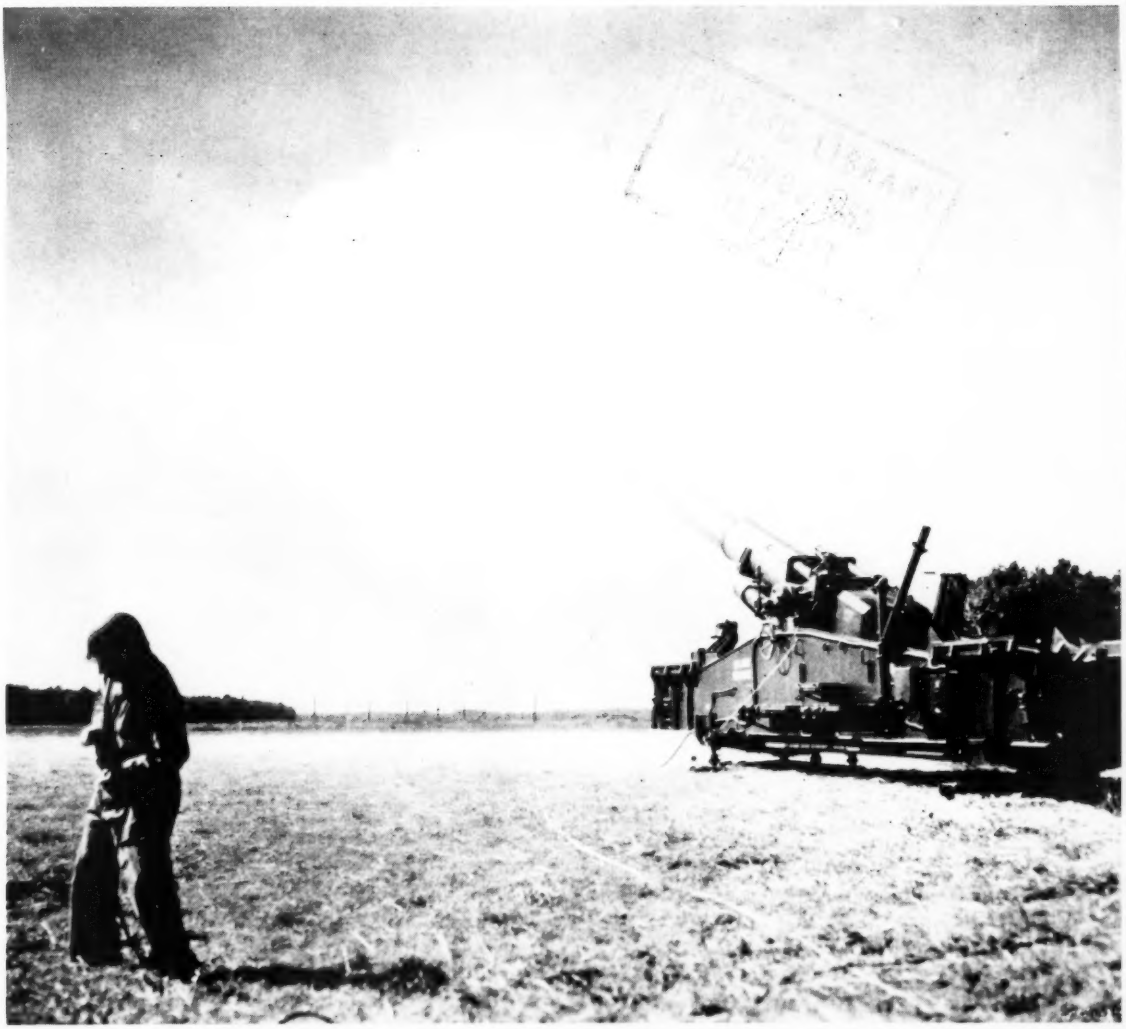

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TURNPIKE FINANCING AND CONSTRUCTION—PAGE THREE

WSE MEETINGS—PAGE TWO

Vol. 5 JANUARY, 1953 No. 8

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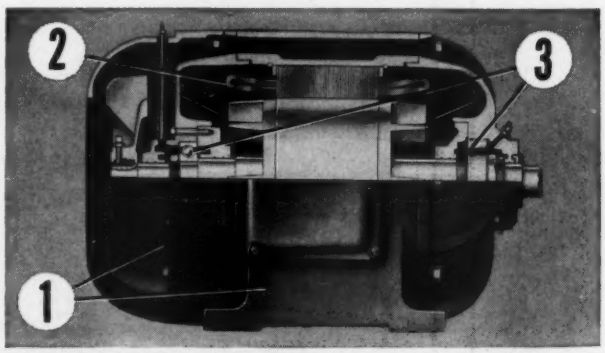

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Cover Story

Double gun recoil in action. "Kick" of army's new atomic cannon being cushioned by two recoil motions. Gunner to the left, standing about 75 feet from the 280-MM gun, has just twisted the handle on the firing key by which the weapon is electrically fired. See Page 31 for an article on this weapon.

January 26, General Meeting

Speaker: E. E. Benzenberg, Senior Coordinator, Hull Division, Gibbs and Cox, Inc.

Subject: "S. S. United States."

Mr. Benzenberg will give a description of the $70,000,000 superliner of the United States Lines. He is a member of the organization responsible for the design of the *United States*, the ship which holds the transatlantic speed record.

Movies of the ship at sea during tests will be shown. Featured will be the ship's fire-resisting hull construction.

A model of the *United States* will be on display, as will the cup which she captured from the *Queen Mary*.

January 28, Noon Luncheon Meeting

Speaker: Fred C. Justice, Publisher, *Mobile Homes Manufacture and Buyer's Guide.*

Subject: "Vacations with Trailers can be Universal."

Mr. Justice will tell you how to combine business with pleasure, or how to convert your business trips into vacation trips via use of a trailer.

February 2, Gas, Fuels and Combustion Section

Speaker: Dr. Donald J. Bergman, Chief Engineer, Universal Oil Products Company, Des Plaines, Illinois.

Subject: "The Case of the Vibrating Stack," an engineering "who dunnit."

Down in the Bahrein Island in the Persian Gulf, Universal Oil erected a thermal cracking unit, including the heaters and a self-supporting stack. Later, an investigation of extreme vibration in the stack during 25-30 m.p.h. winds showed poor ground under the foundation which eliminated charges of poor design. However, another case in England at a later date on which much more data was available brought out another most intriguing cause. Dr. Bergman will tell how a music tuning fork held the answer to the problem. Everyone is invited.

February 9, General Meeting

Speaker: James M. Barker, engineer, banker, merchant and scholar; now Chairman of the Board, Allstate Insurance Company.

Subject: "The Middle East—Geographical Solar Plexus."

Mr. Barker has had a long and varied professional career which included a special mission to Iran for Overseas Consultants, Inc., and one to Turkey for the World Bank. He feels that the Middle East is especially important to the United States. If a blow were struck there, he believes, it could be our undoing. Our position in the Middle East is a lost and hopeless one, Mr. Barker thinks, unless the new administration takes a realistic attitude in this turbulent part of the world.

February 16, Electrical Section

Speaker: J. M. Clayton, Westinghouse Electric Corporation.

Subject: "Lightning Protection for Power Systems," or "Application of the Synchronograph for Solving Lightning Problems."

Mr. Clayton's presentation will review our present knowledge of lightning and its effect on power systems, including analytical methods of solving lightning and arrester application problems. The use of a new instrument known as the "Synchronograph," for solving several types of lightning-protection problems, will be described in detail. An application problem on cable-connected equipment will be demonstrated.

February 18, Junior Division

Speaker: Dr. E. R. Whitehead, Secretary of the Illinois Professional Engineers Examining Committee.

Subject: "The Registration of Engineers."

Dr. Whitehead is a well-informed source of information on matters relating to the registration of engineers. After an informal outline talk, the meeting will turn to a discussion round table, with Dr. Whitehead handling any and all questions relating to the subject.

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Turnpike Financing and Construction

By E. J. Donnelly

From our dictionaries we find the word "turnpike" defined as a road having a tollgate. Recently I have seen turnpikes defined collectively as "Tomorrow's Highways Today." As designed and constructed, today a modern turnpike is an express highway providing its users with a green light from terminus to terminus. It is a highway with a minimum of four lanes wherein all left turns and cross movements of traffic are eliminated through vertical separation of grades at all intersections; opposing streams of traffic are separated horizontally by means of a medial divisor thereby materially reducing the hazard of sideswiping; wide shoulders are provided to permit disabled vehicles to park off the traveled lanes; marginal friction is eliminated through a completely controlled right-of-way with access and egress permitted only at predetermined points where traffic interchanges are provided for such purposes; and grades and curves are designed to provide safe movement of all classes of vehicles at relatively high speeds.

The ultimate completion of a major turnpike necessitates the successful accomplishment and close coordination of six phases which may be called the cardinal elements in the development and operation of revenue bond projects. These elements, which I would like to discuss individually, include administrative, legal, engineering, financing, construction, and maintenance and operation functions. Since the duties of the consulting engineers are not confined to the engineering functions, but rather over-lap into all the other elements, it was considered that a discussion of all phases would prove of interest.

Mr. Donnelly is a partner in the J. E. Greiner Company, Consulting Engineers, Baltimore, Md. He has been associated in the design and construction of turnpikes in several states including Ohio and Pennsylvania. Mr. Donnelly gave this talk before the Western Society of Engineers at the Society's Headquarters on November 10, 1952.

Administration

First and foremost is the Administrative Function upon which the successful completion of all other phases, as well as the project itself, is dependent. The proper execution of this function is the responsibility of the commission or authority, and is the major factor contributing to the success of the project.

In addition to administrative controls and the establishment of general policies, one of the major problems facing executive management is that of organization. The commission must select and organize a team which will share the responsibilities of the various phases leading to the successful accomplishments of the undertaking. In addition to the commission and its organization, the team will include legal counsel, consulting engineers, traffic engineers, financial advisors and a trustee. Subsequent to the sale of bonds, the team must also include designing engineers, contractors and an engineering force to supervise construction. In addition, the commission must develop its own organization to carry out such functions as general administration, administrative engineering, fiscal control of construction funds, right-of-way acquisition and public relations. Following completion of construction, this organization must be augmented with personnel as required to perform such functions as maintenance and repair of roadway and structures, operation of the facility, police patrol and fiscal control of revenues and expenditures. When one considers that a commission or authority, in order to build a major turnpike, must authorize the issuance of revenue bonds in amounts measured in hundreds of millions of dollars, control the expenditure of construction funds in similar amounts, and handle the disposition of revenues amounting to tens of millions of dollars, then the tremendous size and scope of the undertaking and the heavy responsibilities placed upon executive management can be fully appreciated.

The Legal Function

Another phase in the development of the project is the Legal Function. The initial legal step requires that legislative requirements be fully met in the form of sound workable enabling legislation. Then, under the general heading of Legal Functions, we must consider the services of bond counsel who are responsible for all legel matters relating to the financing of the entire cost of the project. In addition to certifying to the legality of the issue and all proceedings connected therewith, bond counsel must also prepare the trust indenture which is a trust agreement between the commission and the trustee. This agreement becomes the basic control of construction and revenue funds, duties of the trustee and consulting engineers, insurance requirements, establishment of reserve funds and various other covenants in the administration and operation of the project.

Another very important component of the Legal Function is the acquisition of land necessary to furnish a right-of-way for the project. One can readily realize the magnitude of the difficulties involved in acquiring the numerous parcels of real estate required for such a project, and in the related problems of consequent damages to severed and adjacent properties. The importance of this element cannot be over emphasized because it very often controls the timing of construction operations and, consequently, controls construction completion which means that delays in construction completion will result in loss of revenues and increased cost of construction by extending the period

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(Continued from Page 3)

over which interest during the construction stages must be paid.

In addition to the acquisition of right-of-way, there are legal negotiations which must be conducted with the various utility companies, the plants of which are affected by the construction and operation of the facility. Also, falling under the general heading of Legal Functions are the contractual relationships between the commission and various engineering firms, contractors, material suppliers and manufacturers.

Engineering

The next phase of the project is the Engineering Function. This phase covers the operations of the consulting engineers in developing the engineering report and the traffic engineers in preparing the traffic and earnings report, such reports providing the basic data for determining the financial feasibility of the project. These reports also provide the basic documents to be used in marketing the bonds.

The first step is the development of traffic-desire lines in the area to be served in order to establish the limits within which the project can be feasibly located from a traffic service standpoint. Within the established limits several routes, which are determined feasible from a construction standpoint, are developed for study purpose. Comparative preliminary estimates of costs and revenues are then prepared to determine which of the routes will provide the best relationship of cost to traffic serviceability. From that point, the consulting engineers develop the preliminary location and the engineering report, and independently of this work, the traffic engineers prepare the detailed analysis of traffic and earnings.

In the development of the engineering report, topographic, hydrographic and cadastral surveys constitutes the first step. For the Ohio Turnpike, aerial surveys, supplemented with such ground controls as were necessary to assure specified accuracies, were used. From these surveys photogrammetric maps were developed and used for determining the preliminary location of the route. The maps covered a band 1000 feet in width and showed contour lines at five-foot intervals. All buildings, roads, oil and gas wells, primary utility lines, streams and land culture were also indicated on the maps. The accuracy of the maps was proven by the minimum of line change required during the final location. From the standpoint of saving in time and cost, the economy of this method was proven.

Modern turnpikes have been developed on the cardinal safety features mentioned hereinbefore designed to minimize highway accidents resulting from several of the major causes.

Analyses of accident records show that these provisions have helped to reduce accidents of the types that occur on highways constructed with one or more but not all four of these safety features. However, over the 10-year period of modern turnpike operation, it has become apparent that there is a marked difference between turnpike and normal highway operation of vehicles. A rather distinct difference has been disclosed in the mental reactions, driving habits and attentive alertness of motorists on ordinary highways as compared to turnpike patrons. Continuous unobstructed and uninterrupted travel for long distance has an effect upon the turnpike operator's mental attitude which differs from the effect upon the attitude of operators on ordinary highways, even though dual lane as well as 2-lane highways be considered. This difference in mental reaction surely accounts for certain types of accidents which occur on limited or denied access highways, in spite of the elements of safety which have been incorporated in the construction of these highways. The motorists and truck operators on turnpikes seem to feel that with payment of tolls they are entitled to a certain relinquishment of vigilance.

All types of serious accidents, whatever their cause, have not yet been climinated by physical safety design features so far utilized.

Because of their frequent occurence and the seriousness of their nature, accidents of three types on turnpikes stand out as examples of the need for additional safety features of design. These accident types are:

1. Accidents resulting from vehicle crossings of the median.
2. Running down pedestrians.
3. Rear-end collisions.

On ordinary dual highways as well as on turnpikes, one of the major accident causes is the crossing of the median. If the opposing lanes are clear, such accidents result in damages to one car only. If the opposing lanes are occupied, however, the ensuing head-on collision involves two vehicles or more.

It may be that the ease of traveling continuously and uninterruptedly has a certain lulling effect on motorists. It

(Continued on Page 10)

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Radio: Founder of a Dynasty

By W. L. Everitt

Modern technology is exerting and has exerted an immense impact, not only on our industrial structure, but also upon our social and intellectual framework. For example, the automobile not only has built an industry producing profits and jobs, but at the same time has changed the life of a nation by making travel and transportation more convenient and available.

Radio has been one of the major technical influences in changing our way of life. In the past half century it has been influential in three areas.

1. As a major manufacturing and service industry, providing consumers' goods and point-to-point communication.

2. As the disseminator of entertainment and information, with a strong impact on our culture and political systems.

3. As the incubator of scientific and technical ideas of widespread interest and application.

The first two areas have received wide attention; indeed, their importance is recognized by everyone. Each could be made the subject of an extended discussion. However, I wish to place primary emphasis on the third area, the impact of radio on scientific and technical thought.

Radio, more than any other existing industry, may be the prototype of our future industrial progress. Its beginnings do not stem from the slow cut-and-try development of artisans and practitioners, as the railroad and the automobile were built upon coach travel. Nor does radio result from the so-called "flash of genius" of the inventors as the great development of mechanical power is commonly believed to have done. Although such artisans and inventors have made important contributions, yet radio had little stimulus from prior technology. Its beginning stems rather from fundamental physical research and mathematical interpretations.

Of the six eras into which I have divided the history of radio, the first is The Era of Fundamental Scientific Research, extending from 1860 to 1895.

The other five eras seem to me to be these:

1895-1920—The Era of System and Device Development.

1920-1930—The Era of Industrial and Spectrum Expansion.

1930-1940—The Era of Engineering Analysis.

1940-1945—The Era of Military Development.

1945- —The Electronic Era

Manifestly, no sharp line separates these—or any other—historical periods. The activities begun in one era continue throughout all subsequent periods, almost always on a continually expanding basis.

1860-1895 The Era of Fundamental Scientific Research

Radio communication, though based upon the work of early electrical experimenters such as Faraday, Oersted and Ampere, is generally considered to start its history with the mathematical researches of Clerk Maxwell. Oersted had discovered that moving charges, that is a current, produced a magnetic field. Faraday discovered that a conductor moving in a magnetic field produces an electric force; Maxwell recognized these as phenomena which could be represented mathematically by two equations relating magnetic and electric fields. The simultaneous solution of these equations showed that electromagnetic fields can exist and that such fields move with a velocity equal to the ratio of two electric and magnetic units. That ratio, independently determined by electric and magnetic measurements, is equal to the velocity of light. This mathematical discovery, made by pure analysis, both indicated the strong probability that light is electromagnetic in character, and predicted that similar waves could be produced by changing currents or accelerated charges.

Maxwell, who had started his work in 1860, made his important contribution in 1865 at the age of 34. He showed no interest in the practical application. He did, however, recognize its scientific importance, for he wrote in a letter to a friend, "I have a paper afloat, with an electromagnetic theory of light which till I am convinced to the contrary, I hold to be great guns." He did his work in the free atmosphere of the University, being a Professor of Natural Philosophy, first at the University of London, and later at the University of Cambridge Cavendish Laboratory, an environment which contributed other great fundamental workers such as Lord Rayleigh, J. J. Thompson, and Ernest Rutherford.

Twenty-two years later, in 1887, another young man, Heinrich Hertz, an experimental physicist also working in a university atmosphere, produced such electric waves with a frequency of about 100 megacycles, a frequency far below that of light but far above that of other electrical phenomena of the time. He also measured their velocity and demonstrated their wave nature by showing interference phenomena and focusing effects. Since both his transmitter and receiver involved spark phenomena, the distance was limited to about 25 feet.

In 1892, another scientist, Sir William Crookes, published an article suggesting the use of these waves for telegraphy across space. He outlined the problems which remained to be solved. They were, to paraphrase his article:

1. A simple way of generating waves of any desired wave length.

2. More sensitive receivers.

3. Tuning systems for making the receivers sensitive to certain frequencies and insensitive to all others.

4. Means for directing the waves from the transmitter in the direction of the receiver.

(Continued on Page 6)

The author of this article, W. L. Everitt, is Dean, College of Engineering, University of Illinois, Urbana, Ill. He presented this as part of the Communications Symposium of the Centennial of Engineering in Chicago on September 11, 1952.

(Continued from Page 5)

Sir Oliver Lodge, a physicist at the University of Liverpool, in 1894 utilized the coherer invented by Professor Branley in 1892 to increase the sensitivity of the receiver, and introduced tuning. In 1895, Professor Popoff of the University of Kronstadt made improvements and introduced an extended antenna and an earth connection.

Of equal importance, for its impact on later developments, must be mentioned the work on what might be called convection currents; that is, the flow of current in evacuated spaces. Notable is the work of Crookes and the subsequent development of a cathode ray oscillograph by Braun in 1897, the discovery of the Edison effect in 1883, and concurrent work by Elster and Bertel on a combination of a heated filament and plate in a vacuum, the work of Roentgen and the identification of the electron by J. J. Thompson in 1897.

1895-1920 The Era of System and Device Development

All the scientific analyses, experiments and conjectures of the first era were necessary before the "invention" of wireless by Guglielmo Marconi, who might more properly be called the "developer" of radio. From 1895 on, the history of radio consisted largely of the recognition of practical problems which needed to be solved and a search for their solution. These problems were of many types: scientific, engineering, organizational, financial and social. Men from a wide variety of backgrounds made their contributions; out of their pattern of thinking has grown a new philosophy of approach to the supplementing of man's senses and brainpower by the technology now called electronics.

It was Marconi who took the results attained by the scientific workers and assembled their ideas and devices into an operating and useful system. He had the inventor's ability to make the required improvements and to drive ahead with demonstrations which attracted the necessary capital. What Edison was to electric power, Marconi was to radio. His genius included commercial organization and development as well as invention. He started work in 1894; his first demonstrations took place in 1896, when he was but twenty-one years of age. These led to the formation of the British Marconi Company in 1897.

Marconi's most dramatic demonstrations took place on December 12, 1901, when, six days after landing in Newfoundland, he detected transmissions of the Morse letter "S" from a station in England. It is interesting to note that if the scientists of the day had been asked for a prediction, they would have said such reception was impossible because of the curvature of the earth. The success of the experiments led Heaviside in England and Kennelley in the U. S. to suggest the existence of an ionized layer above the earth, a suggestion verified and further exploited more than twenty years later.

Marconi recognized the need for further scientific development, and secured the services of Professor J. A. Fleming as a consultant in 1899. In 1904, Fleming applied the Edison effect in the development of the first vacuum tube detector, a diode. This was one result of the general search for more sensitive detectors. Another discovery resulted in the independent development of semiconductor or crystal detectors by Pickard and Dunworthy in 1906. It is only now that we are beginning to understand scientifically why these work, and to expand their utility. In this case, invention preceded science.

In 1897, another important contributor, Professor Fessenden of the University of Pittsburgh, began his work. He early recognized that continuous waves would have important applications in both wireless telegraphy and telephony. He provided the impetus for the development of rotating high frequency alternators, later made practical by Alexanderson and others. He developed the principle of the heterodyne, thus translating frequencies from one part of the spectrum to another. The heterodyne was later to prove one of the most important devices in the bag of tools available to the radio and telephone designer. He also demonstrated the feasibility of the radio telephone. His contributions were great, though the commercial ventures organized around him were never financially successful.

Another important source of continuous waves was the Poulsen Arc, developed in 1903. The use of arcs and rotating generators was limited to the so-called long waves, now called low-frequencies in the radio spectrum. At the time, this limitation did not seem important, because long waves appeared best for long distance application.

In 1906 the search for a sensitive detector produced what many consider the greatest invention of the twentieth century, the three-electrode tube of De Forest. He added a grid to the two-electrode tube of Fleming. This turned out to be the most important step in the development of means for the continuous control of larger sources of electrical energy by smaller sources. Control was not new—telegraph and telephone relays were old at the time—but the latter could operate only on an "all or none" basis. To a certain extent carbon grain telephone transmitters also provided a principle of control but their utility was limited. Although its versatility and importance was not recognized until later the whole field of electronics really began with the invention of the three-electrode tube.

The triode also illustrates one of the special contributions of communication to engineering. Signals are useful even though they are limited to low power, sounds we hear might literally be measured in fleapower. Although new technical devices, like biological creatures, are usually small when they are young, if they apply in the field of communication they can be put to use immediately.

Contrast this with atomic power, which had to be gigantic before it could be used at all. The first electromagnetic dynamo, starting with the Faraday disk, required years of development before it produced useful amounts of electrical or mechanical power. The audion of De Forest, however, found immediate application to the detectors of radio signals.

In 1912 came the next major development. De Forest and Armstrong discovered independently that if the output of a vacuum tube is coupled back to its input, oscillations can be set up whose frequency is easily controllable by a simple tuned circuit. Their work resulted in patent litigation of considerable length and acrimony. However, all radio engineers agree that each made an exceedingly important contribution to the utilization of vacuum tubes and our understanding of them when associated with electrical circuits.

A new source of alternating current of wide frequency range and conven-

(Continued on Page 18)

Future Trends In Aviation

By C. C. Furnas

The expenditures for research and development in the aeronautical sciences, broadly defined, now amount to almost a billion dollars per year. Though recently nearly all of this effort is pointed toward military application, the impact on all forms of aviation is tremendous and leads to a rapidly changing picture.

Commercial Aviation

Barring major military operations, it is anticipated that within fifteen years the commercial airlines of the continental United States will have a traffic load of twenty billion passenger miles per year, which will be an increase of almost threefold as compared to the present. Air freight will also triple in volume. Yet only some 1300 to 1500 aircraft will be used on all domestic airlines—an increase in numbers of only 30 to 50% over the present.

Research and development will play a continuing important role and particular emphasis will be placed upon reliability, comfort, speed and safety. One of the prime requisites of really satisfactory air transport is that it should be practically independent of the weather. Improvement in detection and control systems, such as radar, instrument landing systems, automatic pilots, etc., have brought out a marked improvement in reliability in the last few years and this trend will continue. Heat de-icing for wings and propellers will be improved to the point where icing conditions will seldom, if ever, be a reason for cancelling flights. It is not unreasonable to expect that within a few years 99% of all scheduled commercial flights will operate, as compared to the 94 to 95% now. This will make a tremendous difference in the confidence which the travelling public will have in aviation.

The anticipated increase in speed and numbers of all kinds of aircraft, calls for improvements in the national air navigation system. To handle this need, an Air Navigation Development Board has been set up to promote and coordinate the necessary research and development for a universal continental air navigation system. It is anticipated that a complete air traffic control system will call for a fifteen-year program and the expenditure for full implementation is expected to be well over a billion dollars. This will be a very important phase of the improvement in the reliability of commercial operations.

In the field of comfort, it is anticipated that improvements will be made in the elimination of noise and vibration, in proper air conditioning and in pressurizing the cabin to ground level conditions throughout flight. Gust alleviation devices will probably also be developed. Flying at high altitude in pressurized cabins also greatly improves comfort. All of these items which will call for continuing research and development will pay substantial dividends to the travelling public in the form of more comfortable rides.

The average speed of the larger propeller-driven airliners can be expected to be in the bracket of the transport planes now flying, namely—275 to 325 miles an hour as exemplified by the Douglas DC-6, the Lockheed Constellation and the Boeing Stratocruiser. But propeller-driven aircraft are no longer alone in the commercial field. The British Overseas Airways are now flying British designed-and-built jet-transport aircraft (DeHavilland Comets) on regular runs between London and South Africa, at cruising speeds of over 450 miles per hour. Commercial airlines of the United States are negotiating with British firms for the purchase of some of these jet airliners for immediate American use. At least two major American aircraft manufacturers have commercial jet transports which may be available for use within a few years. Thus the commercial jet-transport age is advancing upon us very rapidly.

Because of the peculiar characteristics of jet engines, in order to obtain reasonable fuel economy it is necessary to fly very high (around 40,000 feet) as well as very fast. This seriously limits the versatility of use of jet transports for many operations. One school of thought contends that the transport aircraft of the future, for most freight-carrying and for low-level passenger transport, will be the turbo-propeller airplane—one in which a gas turbine drives a propeller. The correctness of this contention can not be evaluated until turbo-propeller power plants, now under development for military uses, are either proven or disproven to be feasible. Another school contends that the ultimate power plant for nearly all aircraft will be the "ducted fan" which will achieve the optimum combination of fuel economy, range and speed. It would be a power plant combining some of the features of both the turbo-jet and the turbo-propeller devices. The proof of this contention will have to wait at least several years. It is evident that the intense competition among various power plants is leading to rapid improvement in commercial air transportation.

On a strict ton-mile basis, aircraft can never transport material as cheaply as can be done by various means of surface transportation. The reason is rooted in the laws of physics which are not likely to change. The basic factor involved is the so-called lift/drag ratio: the ratio of the weight supported divided by the resistance to being propelled. Both of these quantities are measured in pounds. Under optimum conditions the highest value of the lift/drag ratio which might be realized for airplanes (at least as we now know them) is about 25. For railway freight trains the value is about 125 and for ocean-going steamships, about 500. Thus you have to push many times harder to propel a pound of weight in an airplane than in a railway train or a ship. But where time is important, for either persons or material, or where the geography is such that accessibility is a factor, the commercial airplane can and does compete very favorably in the overall and complete cost of operation as compared to surface transportation. Thus, there appears to be a very sound

(Continued on Page 8)

C. C. Furnas is Director, Cornell Aeronautical Laboratory, Inc. He gave this address before the Cornell Society of Engineers in Chicago on September 5, 1952.

(Continued from Page 7)

economic basis on which to build an ever expanding air transport industry.

Safety, like morale, is made up of a lot of little things and is always very much in the forefront of the thinking of the aircraft manufacturer and operator, as well as of the passenger. All of the items which make for safety continue to be under careful scrutiny and study by research and development organizations. Recently, the Guggenheim Aviation Safety Center at Cornell University was established to coordinate and catalyze research which it is hoped will eventually ". . . make flying the safest form of transportation." Although the safety record can be improved, it is at the present time—everything considered—quite remarkable. The fatality rate is now about one passenger death per 80,000,000 passenger miles of travel—which is about twice as good as the private automobile, but substantially poorer than railway trains. A recent intensive study of the President's Airport Commission (General James Doolittle, Chairman) resulted in findings and recommendations for the construction and use of airports and of air traffic control systems which will probably be very beneficial in still further improving air safety.

The size of commercial aircraft is determined more by economic than by the technical aspects. Although there is a slow trend towards larger sizes for transoceanic use, it is not likely that there will be many, if any, aircraft in the near future with more than 100-passenger capacity. The bulk of the travel will probably be in the 60- to 80-passenger capacity, with a substantial number of smaller 30- to 40-passenger capacity, for short hops and feeder lines.

Private Flying

Although it is expected that there will be a substantial growth in the use of the so-called executive private airplane, the light airplane, which is now primarily a pleasure vehicle, will probably not show any great increase in numbers. Unless, and until, the light airplane can become a practical travel device in all kinds of weather, it will probably not rise to great importance in the national transport picture. The pilot skill required, weight and cost of equipment for blind flying are such that there is now no prospect of the light airplane in the hands of the average pilot becoming usable for all-weather operations.

Helicopters

The rotary wing aircraft, or the helicopter, actually has better prospects for practical all-weather use than the light fixed-wing aircraft. The helicopter, however, is a complicated and very expensive device, and is by no means easy to fly. Hence, there is very little prospect of its becoming widely used in private operations for the next decade or so. It is proving to be exceedingly useful in military operations, and the impetus from the forthcoming developments might speed up the time scale of private utilization in a manner which is not shown in the immediate prospects.

Military

As contrasted to the trends of commercial aviation, which may seem a little prosaic, the military aviation is well on its way to entering the Buck Rogers era. Mancarrying aircraft have repeatedly flown faster than the speed of sound, and the control systems of guided missiles or pilotless aircraft appear to some to be on the way to making the human being obsolete as a pilot, at least in certain operations.

The emphasis of military development is primarily on speed, automatic control, altitude, and range. The attainment of high speed performance obviously had to wait for the development of greatly improved power plants. The rise of the turbo-jet engine and rockets made it possible for the aeronaut's dream—flight at supersonic speeds—to come true. Because of the tremendous power that is required, flight at supersonic speed necessarily penalizes range and payload. The very high fuel consumption for high speed operations can be partially neutralized by flying at high altitudes. Hence the continuing emphasis on altitude as well as speed. Speed superiority is so important in military operations that the emphasis on higher and yet higher speed for fighter aircraft will probably always be paramount. It can be expected that operational airplanes which can carry on combat at supersonic velocities and very high altitude will be more or less commonplace within a relatively few years.

Though the problems of power plants, aerodynamics and structures occasioned by high speeds are very severe, they are as nothing compared to the complications that are involved in automatic control. Automatically controlled flight involves electronic, mechanical and hydraulic devices which are essentially substitutes for the eyes, brains and muscles of a human pilot. There are a number of approaches to the problems involved which are still highly restricted because of the necessity of military secrecy, but it can be said that research work is going forward rapidly and it is a fer-

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Fire and the Engineer

By W. F. Kuffel

You are unquestionably familiar, in a general way, with the tremendous fire waste in the United States. This is the waste made up of the damage and destruction to property by fire, smoke, water, breakage, and soilure. This is the loss due to the interruption of business, employment, and the use of property. This is the cost of public and private fire protection, the loss of life, and personal injury. But this is a waste that cannot be measured in dollars.

Engineers can usually base their conclusions on statistics. But although the waste by fire in the United States is tremendous, few statistics can be found to emphasize the staggering loss. There are no figures available, for example, on the economics involved in the loss of life from fire, nor are there figures available on the economic losses due to forest fires. Further, there are no figures available on losses of wages, rents, and the use of property as a consequence of fire.

However, figures are published for the past 77 years showing the paid fire losses. But we must realize that these figures are low since there are insurance carriers who do not report their losses to the publishers of the figures. In view of the fact that all of the losses named above grow daily, the published paid losses show a most catastrophic picture, and the graphical curve used to represent them is constantly going higher and higher. While the figures available are for a relatively short period of time, we interestingly note that during the depression years the fire losses were low. Of course, during the war years which saw inflationary prices and values, the losses show an upward trend, but neither the depressions nor the inflations cause fires in the United States. Carelessness causes them!

The fundamental principles involved in fire protection are simple and easily understood, but their application has become a specialized engineering science. Modern industry utilizes a wide variety of complex mechanical and electrical equipment, and the Fire Protection Engineer must understand this equipment.

The most practical solution to the problem of fire loss is to have an under-

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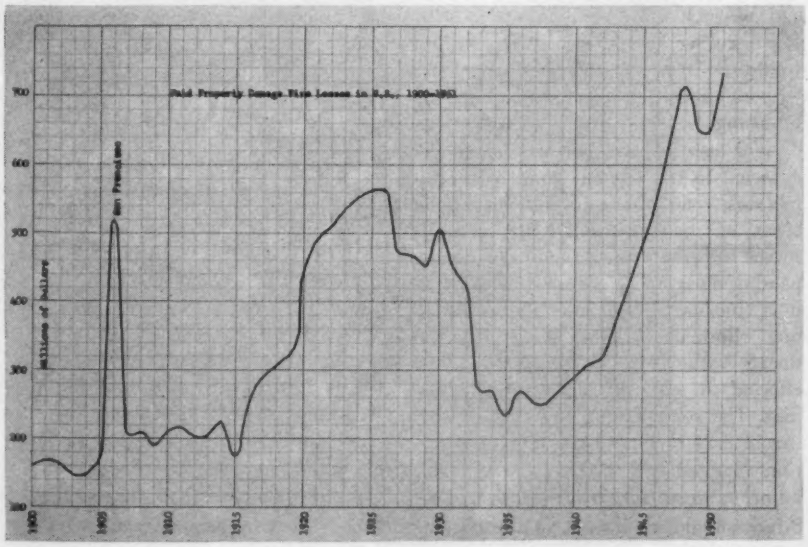
W. F. Kuffel has had wide and varied experience in the insurance business. He has been Executive Assistant Manager of the Rating Bureau, the top executive of an insurance company, and is now President, Kuffel, Eggert and Company, Chicago, a general agency. Mr. Kuffel is a member of the Chicago Committee of the Insurance Institute of America, and is Chairman of the Fire Protection and Safety Engineering Section of the Western Society of Engineers.



Crerar Library

Notes and News

The importance of engineering and modern methods of production to the practical application of new inventions is beautifully illustrated by two small books exhibited in the Crerar Library. A French physician, Denis Papin, published in 1681 and 1687 reports of his invention of the pressure cooker. The first of these two thin volumes bore the title: *A New Digester, or Engine for Softening Bones* (London, 1681). The second was entitled: *A Continuation of the New Digester of Bones* (London, 1687).

In the preface to the second work, the author expressed his adherence to the philosophy that inventors have an obligation to disseminate information concerning their inventions. In presenting his second work, he expressed concern over the fact that *five years* had elapsed since his first announcement without any marked acceptance of his new invention. It is known that a small group of the members of the Royal Society of London enjoyed a dinner prepared in "Papin's Digester." The idea and the known application were clear, but to the five years delay which worried Dr. Papin, there were added almost another 250 years before his idea was put into general domestic use.

One possible explanation may have been in the too limited distribution of Papin's publications. In any case, only two copies of each of these titles are recorded as being in American libraries, including the copies possessed by Crerar. The most likely explanation of this long delay is that without the refinements to be provided by production engineering, it was not possible to bring the then large and cumbersome device into a pattern of practical compactness and ease of use. It is safe to say that the historical collections of the Library contain the dormant records of many other useful inventions.

The current issues of more than 3,000 periodicals are scanned regularly for the selection of technical papers to be included in the several abstract bulletins published by The John Crerar Library. Approximately $25,000 is expended each year for subscriptions for periodicals which cannot be obtained by gift or exchange.

Turnpikes

(Continued from Page 4)

would appear, then, that a physical barrier to prevent crossing of the median would eliminate the type of accidents resulting from the crossing of the median. A continuous barrier in the median, however, would further accentuate the monotony and resulting drowsiness, merely because of the monotonous continuance of a barrier in the median. It is possible, therefore, that the construction of a continuous barrier between the one-way roadways of a turnpike might increase accidents of types other than crossing of the median.

The conditions under which the median crossings occur vary considerably, but they may be classified generally under the terms of "authorized" and "unauthorized" operations.

Authorized crossings of the median are necessary for proper operation of turnpikes. Police must be authorized to cross the median in order to perform their duties, especially with respect to the apprehension of a traffic violator traveling in the opposing lanes. Maintenance crews likewise must be authorized to cross the median to save much time-consuming travel to the next interchange in order to make a return trip to the maintenance building or to carry on maintenance operations on both sides of the median divider.

Under the category of "unathorized" operations are included accidental crossings of the median by vehicles out of control. One of the most common of this type of crossing results from an operator being forced into the median strip during a passing maneuver and thereby losing control of the vehicle. In addition to accidental crossings, "unauthorized" operations also include "U" turns made by motorists to patronize a service station on the other side of the turnpike or to return to an interchange which has been passed.

Pedestrian accidents occur wherever a motorist or passenger steps out of his car either immediately adjacent to or on the paved traffic lanes. Some of these accidents occur in the vicinity of service stations and restaurants where the automobile is parked on the shoulder of the roadway opposite the service station and the motorist or passenger walks across all four lanes of traffic to reach the service station or restaurant on the opposite side. The remaining portions of accidents of this type occur at locations along the turnpike where no apparent reason for stopping exists.

Rear-end collisions involve both parked and moving vehicles. A let-down of vigilance on the part of the operator who rams a parked vehicle, caused by or coupled with drowsiness as the result of the monotony of constant rate of speed and unchanging relation of width and grade of the adjacent travel lanes, seems to be the only explanation.

With knowledge, therefore, of the causes of a large percentage of accidents on modern highspeed expressways, the problem seems then to be resolved into "What additional element of safety design can be incorporated in the construction of turnpikes to eliminate or materially further reduce the accident rate resulting from these known causes?"

The first step in developing the Ohio Turnpike was the treatment of the median divider. Several alternatives have been considered, one of which was the use of a relatively narrow median with a continuous physical barrier between opposing streams of traffic to make it psysically impossible for even out-of-control vehicles to break down the barrier, cross the median and enter the opposite roadway in the face of oncoming traffic. This idea was discarded because of its tendency to increase monotony.

Finally adopted for recommendation is a median divider of sufficient width and of such cross-section that an out-of-control vehicle crossing the median would be trapped and stopped there, without the probability of reaching the opposing lanes of travel. The median divider also includes surfaced shoulders adjacent to the passing lanes of the directional roadways to provide additional areas of maneuverability for vehicles forced off the travel roadways during passing operations. Such a cross-section, it is considered, will also discourage, if not eliminate, unauthorized lefthand turns. Authorized "U" turns would be effected at specially constructed crossings. The roadway cross-section consisting of a 24-foot roadway in each direction flanked by a 10-foot shoulder adjacent to normal travel lanes and an 8-foot shoulder adjacent to the passing lane and separated 56 feet is deemed to adequately serve these purposes.

Also in the development of the Ohio Turnpike, the use of steeper downgrades would make it possible to vary the elevations of the roadways, thereby breaking the monotony of constant horizontal and vertical relationship. In other words, advantage may be taken of terrain by building one roadway higher than the other. Such variation would, no doubt, help to keep vehicle operators more alert and vigilant.

The wide median and the grading of the median are, in themselves, inadequate to prevent accidents involving pedestrians. The increased distance across the turnpike would be a deterrent, in some instances, but would not actually prevent the parking of a car on the shoulder and the occupants of the car from walking across all four traffic lanes and the median divider to visit the restaurant on the opposite side of the turnpike. It might be suggested that the filling stations and restaurants could be located in the area afforded by sufficient widening of the median strip, but to do so would necessitate left hand movements of vehicles across the passing lane in order to enter such filling station and restaurant areas and the re-crossing of the passing lane to return to the normal travel lane. This arrangement would have the result of materially increasing rather than reducing accidents resulting from lefthand turning movements. The placing of service stations opposite each other at each location, however, so that both directions of traffic will be served from the righthand lane, will minimize pedestrian crossings of the traveled roadways at service station sites.

A geological study of the entire route is made to determine foundation conditions; the types of materials to be encountered in cuts and embankment areas; the availability of natural materials suitable for incorporation in the construction; and to develop the problems created by the presence of coal, oil, gas and other mineral deposits along the route.

In the case of the Ohio Turnpike, these studies were based upon all available data from State and Federal geological agencies; aerial mosaics developed

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THE NEXT STEP...

..IN THE DEVELOPMENT OF AN ENGINEERING AND SCIENCE HEADQUARTERS

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has been taken by many of the members of WSE, and sizable funds have been received or pledged.

However, our goal has not yet been reached. We ask, therefore, "Has the second step been taken by you?"

Charles E. De Leuw,
Chairman

D. Van Gorp
B. A. Gordon
G. L. Jackson
Co-chairmen

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from the surveys; field investigation of natural outcrops, mine openings, existing cuts, etc.; and preliminary electrical resistivity surveys. These studies focused attention on problems which were assessed and resolved into design and construction procedures which ultimately proved to be satisfactory solutions.

The establishment of roadway design criteria is the next step in the preparation of the engineering report. This includes the development of roadway cross-section; design of pavement, subgrade, shoulders and medial divisor; limits for benching in cuts and on side hills; maximum grade and curvature; and such other controls as design speed, rates of superelevation and spirals, clear sight distance on curves, rear end sight distances and such other factors as must be incorporated in a project designed to provide its users with the maximum possible degree of safety. In addition to the roadway, proper standards are developed for such roadway appurtenances as guard rail, delineators, right-of-way fence, lighting and roadway signs.

Drainage design criteria is another very important element in the development of a turnpike project from the standpoint of both cost and serviceability. On such a highway, which is selling service to the motoring public in the form of safe, high speed, all weather transportation, interruptions, and delays to traffic resulting from a flooding condition would be intolerable. Therefore, the standard of design must be sufficiently high to assure proper collection and disposition of surface water without causing roadway damage or creating traffic hazards in the form of washouts, roadway flooding, landslides, shoulder erosion and deposition on the shoulders of material eroded from areas beyond the limits of the roadway.

For the Ohio Turnpike, surface drainage was divided into three classifications: (1) streams and drainage areas having a contributory area of 400 acres or more, (2) minor streams and small outside drainage areas and (3) roadway drainage including cut slopes, shoulders, medial strips, storm sewers and underdrains. Complete design criteria were developed for each classification and hydraulic charts prepared as the basis of drainage design for the entire project.

Design criteria for all structures including highway and railroad grade separation structures, drainage structtures and major stream or river crossing must be developed. A review and analysis of all state, county and urban plans of highways intersecting the turnpike are required so that structures properly located and of sufficient capacity can be planned to accommodate such highways. Similar studies must be made of all railroad crossings. The roadway width, span-length and locations of every structure over and under the roadway must be determined and agreed upon by all agencies involved.

Interchange locations must be selected on the basis of traffic demands as developed from the origin and destination surveys prepared by the traffic engineers. Design criteria covering such elements as acceleration and deceleration lanes, curvature and grades of ramps, and number of toll lanes must be developed.

One of the features of a complete interchange facility is the establishment of a toll collection system to classify types of vehicles, to assess appropriate rates to each classification, to insure proper recording of tickets issued and fares collected and to establish adequate controls.

In order to safeguard the toll revenue at each plaza, it is desirable to include provisions in this system whereby the collecting operation will be self-checking. This can be accomplished by including in the toll collection system adequate means whereby:

1. The toll from every vehicle is recorded.
2. The recorded toll is the same as that which was collected.

The collection system must be capable of rapid and efficient operation, consistent with the services which are being rendered to the patrons. From the patrons' standpoint, therefore, it is desirable to provide a collection system which:

1. Is rapid in operation.
2. Requires the least effort on the part of the patron.
3. Leaves no doubt as to the disposition of the toll.

The magnitude of the toll collection problem makes it necessary to consider its cost of operation and its adaptability to proper accounting of the receipts. If the revenue of each interchange is to be checked regularly, the means whereby the multifarious combinations of trips and classifications may be sorted and combined to secure the proper financial control is an integral part of the problem. Consolidated records of the transactions at each interchange are not

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only required for auditing, but also for traffic promotion and other administrative purposes. A proper toll collection system therefore must include the following:

1. A vehicle classification record of the traffic passing through each interchange.
2. A trip-length record of the vehicles entering and leaving the Turnpike at each interchange.
3. A summary record of the receipts paid by each classification and for each trip.
4. A correlation of each record with the collector on duty.
5. A continuous, or periodic, detailed record of every transaction made by a collector.
6. An independent check on the number of vehicles entering and leaving the facility at each interchange.

For the Ohio Turnpike it is planned that classification of vehicles will be accomplished through the medium of a roadway scale of the strain gauge type. As a multi-axle vehicle approaches the toll booth, each axle will be weighed and recorded electronically. The toll collector then merely pushes a key indicating the number of axles that the vehicle has and a classification card is thereby ejected from the classification machine. Imprinted upon the card will be the interchange number, the lane number, the collector's number, the time of entering, the gross weight of the vehicle, the maximum axle weight of the vehicle and the classification of the vehicle. When this ticket is surrendered at the point of exit, the collector inserts it in a machine that is sensitized by the marking indicating the point of entering and the classification and automatically computes and prints upon the card the fare charges.

Plans of all utility lines crossing the turnpike must be reviewed and analyzed to determine the extent of damage and re-location work that must be accomplished to accommodate the construction of the project.

Maintenance buildings must be located and fundamental designs based on the requirements of the maintenance forces must be prepared.

A communication system serving fixed and mobile stations for the entire length of the highway is usually incorporated in the project in order to offer a maximum of protection, service and traffic control.

In the case of the Ohio Turnpike, the length of the project, together with the isolated character of a considerable portion of the territory traversed, requires a radio communication system for police control, contact with State Police, regulation of traffic, reporting accidents, break-downs, fires, summoning doctors and ambulances, reporting weather and road conditions, interchange of certain information relative to toll collection activities, abnormal roadway maintenance situations, snow removal and cindering operations and many administrative purposes. The planned communication system in Ohio will meet these requirements and provide the following services:

1. Two-way voice communciation between mobile units operating on the entire length of the Turnpike.
2. Two-way voice communication between mobile units and fixed stations along the Turnpike.
3. Two-way voice communication between fixed locations along the Turnpike.
4. Two-way teletype communication between selected micro-wave stations.

Selection of service stations and restaurant sites must be determined in order to adequately and conveniently serve the patrons who are expected to use the facility.

Surveys must be made to determine the availability of various types of construction materials in sufficient quantities for such a large project. Review of the program of the State Highway Department contemplated for accomplishment during the construction period of the turnpike must be made to determine the effects of the impact of such a project on the construction industry as a whole. Mass diagrams are prepared to establish limits of balanced sections of highways for the purpose of determining the approximate lengths of contracts. Recent bidding for similar work in the area must be analyzed and, if possible, a price trend established for the bidding period of the project. All of these elements are of prime importance in establishing estimated unit prices for the various items of construction work to be incorporated in the turnpike.

With all of the aforementioned factors determined, the quantities of all construction items to be incorporated in the project are computed, against which are applied the estimated unit prices, thereby determining the estimated construction cost of the project. However, the estimates of complete project cost for the type of revenue bond financing involved in the development of a turnpike must include not only the cost of construction, but also the cost of preliminary investigations, studies and reports; the cost of right-of-way and property damage, including all incidental costs of acquisition; engineering and architectural cost; legal and administrative cost; and the costs of equipment and supplies required to put the facility into operation upon completion of construction. In addition to the estimate of total project cost, the engineering report must also set forth a forecast on the cost of maintaining and operating the facility so that net revenues (gross revenues less cost of maintenance and operation) can be ascertained to be sufficient to pay

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The Whole Loop at its Doorstep

(Continued from Page 13)

interest upon and amortize the entire investment.

Within the Engineering Function, the companion component of the engineering report is the traffic and earnings report. The traffic engineers evaluate all traffic data assembled by the highway department and make field surveys to determine the origin and destination of vehicles using major highways in the vicinity of the proposed turnpike. In addition, such factors as population trends, industrial trends, records of automotive registration and gasoline consumption and other similar related data influencing vehicular travel and traffic potential are reviewed. From an analysis of these data, the traffic engineer pre-determines the volumes of traffic that will use the facility and the gross revenues that will be derived therefrom.

The end result of the Engineering Function is to assure the investor that the amount of funds estimated for the project will be sufficient to fully cover all costs necessary to carry the project to completion; that the estimated annual expenditures for maintenance and operation will be sufficient to keep the facility in first-class operating condition; and that the prediction of net revenues will fully cover, with a factor of safety, all the debt service charges. It is, therefore, the experience and ability of the consulting and traffic engineers that measure the confidence of the investors in the project, as well as the hazards and risks to be assumed by the investors.

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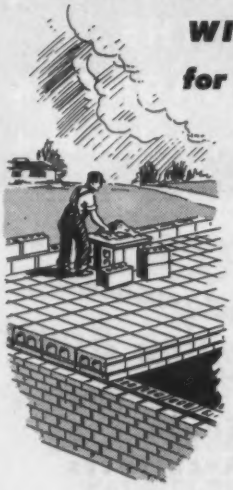

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Financing

The fourth cardinal phase of the project is the Financing Function. It is at this time that the principal underwriters enter the picture to evaluate the cost and revenue reports, to gauge the risks involved in the project, and to ascertain that the debt service coverage is ample to assure the marketability of the bonds. The principal underwriters also advise in the preparation of those portions of the Trust Indenture affecting the marketability of the bonds and prepare the "Official Statement" or "Bond Prospectus." This document is a presentation of facts concerning the project and contains a recitation of the legislation, a description of the project, a summary of the provisions of the trust indenture and statements of the consulting and traffic engineers relative to project costs, maintenance and operation, and traffic and revenues. The bond market must be analyzed so that interest rate and bond price can be approximately fixed. At this point a turnpike project is complete on paper and it is then incumbent upon the principal underwriters to develop a market for the bonds.

A bond issue of the size required for a major turnpike project must of necessity be distributed on a nation-wide basis. Therefore, the first step toward developing a market is usually the formation of what is normally called an "underwriting group" which would consist of approximately one hundred to two hundred investment banking firms, depending upon the size of the issue. The next step is usually to satisfy "key investors" or large buyers such as insurance companies as to the soundness of the investment. The purpose of this step is not only to sell large blocks of bonds,

(Continued on Page 16)

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HENRY COFFMAN, Chairman

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Membership Committee

Turnpikes

(Continued from Page 14)

but also to obtain approval of the issue by large institutions with expert staffs which make extensive and detailed independent investigations. In many instances, other buyers are favorably influenced by such approval. With the marketing of the bonds, the objective toward which the Financing Function is directed has been accomplished.

Construction

With the money now in the bank, we come to the Construction Function. Construction can be successfully accomplished only through the fullest cooperation between executive management, engineers and contractors. During this phase, more so than in any of the others, time is of the essence. Every step and every operation must be closely coordinated so that lost motion or time will be held to a minimum.

Before actual construction can commence, final surveys must be made and designs, contract plans and specifications must be developed. Although these operations are of an engineering nature, they are and must be considered as part of the Construction Function. Since the design stage must of necessity be accomplished in a minimum of time, every available means which meets the requirements of accepted standards must be utilized. In this regard, it should be noted that the use of the electrical resistivity method of determining subsurface conditions was instrumental in saving considerable time during the design period of the Pennsylvania Turnpike Extension.

The use of resistivity surveys for the solution of certain sub-surface problems in modern highway design and construction is not new. For some years, the Bureau of Public Roads has been particularly active in conducting basic research and field test of methods and equipment. Also, in cooperation with that agency or independently, a number of state highway departments have successfully applied the technique to their needs. However, there is ample reason to believe that the surveys completed in connection with the Pennsylvania Turnpike Extensions represent the most extensive and comprehensive application of this method to highway work to date.

On the turnpike extensions, resistivity surveys were carried out in conjunction with the test drilling program. A minimum of one core boring was made in each cut over fifteen feet in depth and the cut was surveyed in detail by resistivity measurements at one hundred or two hundred feet intervals. The resistivity data were correlated with the boring logs and the resulting interpretations of depth and character of bed-rock were determined. A detailed master profile was prepared on which was plotted all sub-surface data including core boring logs, hand auger boring logs and resistivity survey results. This profile was of considerable value in determining the quantities of rock excavation and the proper design of back slopes and benches in cuts.

As each section of roadway became ready for contract letting, a summary report was prepared setting forth the general geologic conditions in the section together with a tabulation of the results of the resistivity surveys and core boring operations. These reports were made available for examination by prospective bidders. Although it is not possible to accurately evaluate the worth of these data, there is little doubt that unit prices for roadway excavation were favorably influenced as a result of this information.

A very important element in the final planning stage, is the determination of the size of the sections into which the entire project is to be divided for contract purposes so that the maximum number of available contractors are attracted to the project. The basis of this determination is the data compiled during the preparation of the engineering report mentioned heretofore in the discussion of the Engineering Function. In the case of the Pennsylvania Turnpike Extension, the basic sections averaged three to four miles in length and the scope of the work in each contract included grading, drainage, paving, and structures within the section. Several contiguous sections were advertised simultaneously and a given contractor was permitted to bid on one, any combination of, or all of the sections. It was proven that this method was favorably received by the contractors in general and resulted in a maximum of competition.

During the actual construction operations, it is the mutual responsibility of the engineers and contractors to produce a sound, durable facility in a minimum period of time. This means that problems arising during construction must be resolved promptly and decisions affecting construction operation must be handed down without delay. In this respect, it should again be mentioned that right-of-way acquisition is a most important element in assuring normal sequences of construction operations without delay or interruptions.

Maintenance and Operation

The Construction Function attains its objective the day the facility is opened to traffic. Although it is a popular conception that the project has reached its ultimate conclusion when construction has been successfully accomplished, there is still another function toward which all other phases have actually been directed, namely the successful maintenance and operation of the facility. It is during this function that the true success or failure of all of the other elements can be measured. However, the

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success of this phase of the project is dependent upon good executive management because this phase is the direct responsibility of the commission or authority. Under the terms of the trust indenture, the commission covenants to perform these services in an efficient, sound, businesslike fashion, and at a minimum of cost. The trust agreement also provides, however, that the consulting engineers will assist the commission in the performances of its duties through engineering supervision of maintenance and operation procedure and through recommendations covering such operations together with the estimates of funds required for these purposes.

It is incumbent upon management that the roadway at all times be maintained to the highest possible standards, thus permitting the safe passage of large volumes of traffic. It means that the road must be ever open to traffic regardless of weather conditions. On this point, it may be interesting to note that the Pennsylvania Turnpike, for its entire completed length of two hundred sixty miles, was never closed to traffic during the severe snowstorm that occurred in the latter part of November, 1950.

In addition to the maintenance of the physical plant, there are many operational problems involved, including a system of fare collection and the depositing of revenues; police patrolling of the highway; constant attention to safety of operations which means the development of safety programs and policy in conjunction with trucking firms, public carriers, transporters of explosives and the like; provisions for emergencies such as fire equipment, ambulances and authorized motor services for disabled vehicles; and finally, an organization capable of carrying out these operations with a high degree of efficiency.

While fiscal control is an element of Administrative Function, it is difficult to separate it from the function of maintenance and operation because therein lies one of the major controls exercised by executive management over the operation of the facility. The trust indenture dictates what is called the flow of funds, which has frequently been described as a series of buckets; each bucket in turn being filled before proceeding to the next. The revenues collected go first into the revenue fund, then to the current expense fund, the sinking fund, the insurance fund, the replacement reserve fund, the reserve interest account, and finally to the redemption account. Only through adequate fiscal controls can the funds be properly channelled. To accomplish this end, a system of fare auditing must be established to provide daily statistical control and a system of accounts developed to assure current control of expenditures.

Throughout the development of the cardinal functions creating a turnpike project, it must be recognized that the keynote is teamwork. Only through the utmost cooperation and coordination among the various individuals and groups of individuals can a project of this type be brought to a successful conclusion.

Scientific Research Must Benefit Public

Scientific research is justifiable in the long run only if it benefits the public, Dr. Haldon A. Leedy, director of Armour Research Foundation of Illinois Institute of Technology, Chicago, said December 29, in St. Louis.

Dr. Leedy spoke before the American Association for the Advancement of Science, meeting in St. Louis.

"Research must be initiated in the public interest, either immediate or ultimate," he stated. "Industry engages in research in an understandable and healthy desire for future profit, but projects that benefit the public are the only ones that justify themselves over the long pull."

Using part of the nation's inadequate pool of technical manpower for unsound research objectives is both wasteful and shameful, Dr. Leedy continued. Besides, he said, the research institution's reputation and future are at stake, too, so it wants above all to do a commendable job for a worth-while purpose.

"That purpose might be to produce a less expensive washing machine, a stronger type of concrete, or a more nutritious breakfast food," the Chicago scientist said. "But all worth-while projects can be described as the practical application of science to better living. I doubt that there could be a more lofty objective for industrial research."

Two Utilities Ask for Merger

A petition was filed December 12 with the Illinois Commerce Commission asking approval of a plan to merge Public Service Company of Northern Illinois into the Commonwealth Edison Company.

Edison, which owns 99.87% of the capital stock of Public Service, last month announced that consideration was being given to the merger proposal as a corporate simplification measure. The merger plan involves no change in personnel or operations. Under the proposal the business in the Public Service Company territory would be conducted by the "Public Service of Northern Illinois Division."

Because the proposal involves a statutory merger, approval to put the plan into effect also will have to be obtained from the companies' stockholders.

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(Continued from Page 6)

ience was now available. Its first importance was a low power source; it made the heterodyne principle of Fessenden useful at the receiver. This in turn led the way to Armstrong's development, in 1917, of the superheterodyne, a principle which is still the basis of modern sensitive radio receivers at all frequencies.

Subsequent developments in tubes expanded the power available from milliwatts to megawatts. This new tube development started in 1912, with the work of Arnold of the Bell System and Langmuir of General Electric. Arnold's work was initiated because it was realized that the triode provided the practical key to the problem of telephone repeaters, a device essential for the expansion of telephone interconnection on a transcontinental basis. Both Langmuir and Arnold recognized that tubes must be more completely evacuated in order to give proper and reproducible control of the output power. Multi-stage audio amplifiers then became practical. High vacuums and improved filaments also proved the key to higher output powers.

Although Alexanderson had developed a magnetic method of modulating the output of his high frequency generator, his method was not efficient. Heising developed a vacuum tube method for controlling the output of a vacuum tube oscillator which provided the key to modern radio telephony.

In 1915 the Bell System demonstrated transatlantic and transpacific communication using vacuum tubes as amplifiers, modulators, oscillators and detectors, the combination now universally used.

1920-1930 The Era of Industrial and Spectrum Expansion

Until the end of World War I, radio can hardly be considered to have had much impact as a new industry. Its principal social service had been to contribute to the safety of life at sea and as a minor competitor of the transoceanic cables. The large electrical firms had given it only slight attention, except by adopting its byproduct, the audio amplifier, into the structure of transcontinental telephony. However, long distance telephony represented only a small proportion of the telephone business at the time.

All this was changed by the development of new applications—radio broadcasting and the byproducts, the public address system, and the talking movies. The basic developments had been completed. A new consumer's good was ready for the market; profits were to be made and investments lost. The work of the industrial organizer and manufacturer, the developer of mass production methods, and of entertainment directors overshadowed the continuing work of the radio engineer and scientist.

But let us concentrate on the work of the smaller group who were still preparing the way for the applications of the future.

Concurrently with the industrial expansion, concentrated so largely on home radios and the revolution in the moving picture industry, was an expansion in the understanding and utilization of the frequencies which could be employed.

Analyses, particularly by Carson on the nature of signals and of the effect of modulation, showed that the radio spectrum could not be indefinitely subdivided by selective circuits, but that a finite band of frequencies, whose width was determined by the nature of the signal, must be assigned to each channel. Telephony requires a wider band than telegraphy, and television very much more. It was also shown that the band width depends upon the method of modulation; frequency modulation requires at least as much as amplitude modulation, and generally more.

The rather crude methods of measurement available in 1912 had indicated by the work of Austin and Cohen that radio waves were attenuated less and less as the frequency was reduced. This work was substantiated by the qualitative observations of practical experience. We must remember that spark and arc oscillators and rotating machines only made high powers available at what we would now consider low frequencies. The vacuum tubes available after the war produced moderate powers in a new frequency range. The radio law of 1912 had assigned frequencies above 1,500,000 cycles to the amateurs as being worthless. But if each signal occupies an appreciable band width, the number of channels below 1.5 megacycles is severely limited.

Experiments by the amateurs in their "useless" frequency regions and by Marconi on his yacht *Electra,* discovered a surprising new phenomenon: long distances *were* possible at higher frequencies with only moderate power. But whereas the low frequencies produced consistent results in the absence of atmospheric disturbances, the higher frequencies seemed erratic, giving long ranges at one time and nothing at others. The ionosphere proposal of Heaviside and Kennelley was recalled, and this ionosphere was correctly suspected to be the mechanism which would reflect these higher frequencies. Breit and Tuve, with pulses which anticipated radar techniques, established beyond question the existence of this ionosphere and measured its height. Here was a new region of our terrestrial globe to be explored, as challenging to the scientific radio investigator as Columbus' discovery was to the geographic adventurer. Knowledge of the ionosphere, its layers, its frequency characteristics, and its daily, annual and long-time variations was rapidly accumulated. This knowledge could be used immediately, for the known radio spectrum was crowded with

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new communication services between continents and for ship and aeronautical services. With knowledge of the ionosphere, reliable radio communication on many channels became possible.

Concurrently with the discovery of new available channels at higher frequencies, it became necessary to study the limitations of vacuum tubes at these higher frequencies and to develop new tubes to overcome the recognized limitations. At first it looked as if the new frequency range would be limitless, depending only on the development of tubes, but it was discovered that at any given time there is a maximum frequency which can be reflected from the ionosphere, and a new boundary appeared to block progress. However, the development of new services useful at moderate ranges, such as television, radar, and aeronautical communication services, found applications for these still higher frequencies in the 1940's.

The higher frequencies made another important device practical. Although Crookes in his paper of 1892 had shown the utility of a directional antenna, and Franklin had identified its principle, waves can be focused only by sources which have dimensions of the order of several wavelengths. Since wavelength is inversely proportional to frequency, the higher frequencies were necessary before economical transmitting antennas could be designed to save power by sending their waves in the direction most needed. Much attention was paid to the design of such antennas. The expansion of the frequency spectrum also necessitated the development of accurate means for frequency control. Such a means was provided by the piezo electric crystal oscillator.

During the war, Major General Squier, Chief Signal Officer of the Army, had suggested that the techniques of radio might be applied to the waves which are guided by wires. These techniques would increase the number of signals which could be sent over a single telephone line. This application was first termed "wired wireless" and later was called "carrier current telephony." It was developed extensively by the Bell System. In exploiting this area of frequency expansion in wire guided systems, further studies resulted in a greatly improved knowledge of electrical circuits, particularly as applied to wave filters. A more definite understanding of the nature of signals and the possibilities in the modulation process also resulted.

1930-1940 The Era of Engineering Analysis

During the 1920's, radio was developing from an art based upon the original experimental science, which, except for the mathematical work of Maxwell, had been largely qualitative, toward an engineering science whose systems could be designed and perform as predicted. An operating and manufacturing system of wide scope had developed.

What was still lacking was numerical precision. Lord Rayleigh had said, "You do not have a science until you can measure." Before World War I, the only reliable measuring devices for radio frequencies were the hot-wire and thermocouple ammeters. Therefore, only current was known with reasonable accuracy. Attention was first directed to the measurement of resistance and sub-

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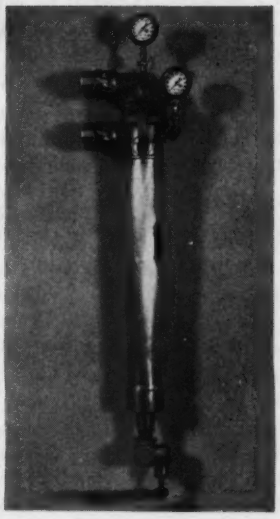

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(Continued from Page 19)

sequently to the measurement of voltage, field strength, and frequency. With field strength meters, true knowledge of propagation characteristics both over the earth and via the ionosphere became possible. The output as well as the input power of antennas could be determined. Improvements, in themselves small, could be identified and cascaded for worthwhile results.

Another important measurement tool received much attention, the cathode ray oscillograph. This was later to become the output device for presenting information to the human observer in television and radar, but its original development centered around the measurement of wave form and voltage. In order to improve the oscillograph, a new subdivision of physical science was developed: electron optics. Out of this came electronic television and the electron microscope, both closely identified with the work of Zworykin. George and Farnsworth also contributed significantly to electron optics and television.

The mention of Zworykin highlights the fact that with the industrial expansion and the increase in the economic importance of radio, more and more of the research and development was identified with teams centered in industrial laboratories maintained by the manufacturing companies rather than with the individual working in his personal or university laboratory.

Progress continued on the development of amplifiers at all frequency ranges. The feedback from the plate to the grid in a triode, though necessary in an oscillator, was nevertheless a difficult thing to control in an amplifier. Devices used to overcome it in the 1920's were the bridge circuits of Rice and Hazeltine and the screen grid tube of Hull. The problem led to a fundamental analysis of feedback systems by Nyquist. This analysis has more recently had wide application in systems of control called servomechanisms. Such systems of control measure the difference between a desired condition or standard and an actual situation. This difference is used as a signal to control, usually through an amplifier, a source of power to correct the situation and reduce the error signal. Servomechanisms may control the speed of an industrial process, the temperature of a room, the pointing of a gun, and many many other operations. The system may be electrical, mechanical, thermal, for instance, or any combinations of these.

It has also been found that this process is inherent in many biological organisms; we live and move by such an action. Thus, out of the study of the radio amplifier has arisen a new understanding of biological processes and the means by which we can supplement our human senses in the control of machines and industrial processes. All this is a part of the new science of electronics.

The analytical study of feedback also led to new notions of how to stabilize active networks and measuring systems employing amplifiers, which previously had tended to be erratic and subject to uncontrollable variations. Vacuum tube voltmeters became widely used.

Radio has always had a principal enemy: noise. Any communication system is limited in its ultimate range when the noise becomes too large in comparison with the signal. In the early days of radio, static provided the noise of most interest. As amplifiers became more sensitive, another noise identified was the random motion of electrons in those portions of the amplifier where the signal is weak.

The early efforts of radio to overcome noise centered around making the transmitters more and more powerful and the receivers more sharply tuned. While this increased the range, the problem required further attention. New studies therefore centered around the nature of signals, how they may be transformed by different methods of modulation while still making them recoverable by a demodulation process. One of the most dramatic methods for reducing noise was provided by a new frequency modulation system developed by Armstrong.

This in turn laid the groundwork for other developments, such as pulse modulation, and for new insight into the nature and control of random fluctuations of many types. The importance of a statistical approach to propagation, noise, and information theory became evident.

1940-1945 The Era of Military Development

I can only touch briefly on how radio contributed to the war. Unlike World War I ,World War II caused a dramatic increase in applied radio research, centered around the use of higher and higher frequencies. The most dramatic application was in radar. Electronics is a *must* in modern warfare, because movements are so rapid that decisions must be made in fractions of a second. For example, in counteracting the V-I bombs, radar measured where these flying missiles were, vacuum tube computers calculated where they were going to be; this information through servomechanisms pointed the guns, and the shells carried radio-controlled fuses which told these shells when they were in the vicinity of their target, exploding them for maximum damage.

In this period, an extension of the use of electronic calculations brought us into the post-war period, where problems of great numerical complexity could be tackled.

1945- The Electronic Era

I have said little about the development of television, because this radio application is of such importance that it

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must be the subject of a separate paper. Suffice it to say that it has released a new industrial expansion as well as stimulated new intellectual endeavors.

From all this background comes a new importance in the application of circuits and devices originally developed for the various fields of radio and carrier telegraphy, telephony, and television. It has been recognized that in many industrial processes signals can be generated and used to monitor and control these processes. Photoelectric cells can replace eyes to observe color, position and size. Variations in capacity can generate signals proportional to displacement. The information can be given to human operators for their action or, in many cases, human observers can be eliminated and the signals used directly to provide corrective control of the processes. Thus, electronic systems can actually exercise judgment, that is, they can make decisions on the basis of information they collect, and if necessary they can compute from the data before they reach the decisions. They can then give commands on the basis of these decisions. Thus they are, in truth, brains. All of this new technology is founded on the original contributions of radio, whose devices were first used when they were small.

Modern industry is founded on the use of mechanical and electrical power to replace man's muscles; electronics more and more provides the routine brain power and nervous system for control of its repetitive tasks.

Various definitions of electronics have been given; I would suggest the following as its present accepted meaning, although you will not yet find it in the dictionary:

Electronics is the science and technology which deals primarily with the supplementing of man's senses and his brain power by devices which collect and process information, transmit it to the point needed, and there either control machines or present the processed information to human beings for their direct use.

Thus, out of radio have grown many new concepts of great utility. It has founded a new technical dynasty, the dynasty of electronics, a dynasty to reign over and guide, under the control of man, his other mechanical servants.

Long may it reign.

Aviation

(Continued from Page 8)

tile hunting ground for the physicist, mathematician and mechanical engineer.

Although the average operating altitude of military aircraft has crept steadily upward, it has not made any spectacular progress in recent years. Experimental rocket-driven aircraft, however, have achieved much higher altitudes than operational military aircraft. Because of military secrecy, however, the data have not yet found their way into the public books of records. It can be expected that completely sealed military airplanes with various types of power plants will be operable in the general range between 50 and 100,000 feet. Pilotless aircraft, or guided missiles, of the rocket-driven type have—as is well known—ascended to altitudes of many miles. The highest publicly reported flight made by a two-stage rocket was 208 miles above the earth.

Military aircraft have their prosaic side, too—it's not all "wild blue yonder." The largest airline in the world is the Military Air Transport System which transports men and material to all parts of the world in the same types of aircraft which the commercial airlines use. Military air transport is increasing rapidly and even in the limits of continental United States may soon be equal in volume to the total commercial air transport. Military operations, over both land and sea, now call for extensive use of helicopters, and light, fixed-wing aircraft of various types, for observation, rescue work, reconnaissance and local transportation. Thus the military field is proving to be a very useful laboratory for the development of new types of machines as well as for the solution of operating problems which are of direct commercial, civilian benefit.

Long range, coupled with great weight-carrying capacity, is obviously a military necessity in some types of airplanes. The world's record endurance flight thus far has been about halfway around the world. This, however, was accomplished with very little useful load. New fuels, lighter power plants and aerodynamic improvements may be able to extend this range somewhat, but there is no immediate prospect of phenomenal improvement. Where the situation is such that refueling in the air can be employed, the practical range of certain airplanes, such as fighters and heavy bombers, can be extended. The use of this technique, however, has certain very definite restrictions—particularly in strategic operations. Hence, no really striking advances in the range of useful airplanes can be anticipated until, and if, a power plant that uses nuclear energy is developed. In that case the range would be practically limitless. Although a large military project in the development of nuclear propulsion of aircraft is underway, there is no real assurance of ultimate success and, in any event, practical results can not be expected within the next few years.

It will be observed that the major improvements in aircraft and their use has very often been spearheaded and financially supported by the military. This has been true in all countries. Thus, when and if the era of universal peace does eventually come, the principal monument to military effort may be embodied in the very extensive world-wide system of safe, rapid, convenient, comfortable, dependable and inexpensive air transportation which will extend literally over the entire world and which will be a vital part of the life of every citizen. It is conceivable that some of us may live to see the dawning of this True Air Age.

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Fire

(Continued from Page 9)

standing between the Fire Protection Engineer and the engineer in the other branches of the profession. Only the continuing cooperation of all engineers will solve the problem.

Understanding is required. Mechanical, Electrical, Chemical, Architectural, and Civil Engineers find it necessary to consult with one another when the task requires specialized knowledge of engineering beyond the scope of their individual field. The Fire Protection Engineer should be consulted, too. His science can help you, and in helping you, reduce the fire waste in the United States.

Of the hundreds of thousands of fires each year, the actual total cost of fire waste is probably more largely affected by the spread of fire than by the number of fires. To the Fire Protection Engineer, therefore, an understanding of the circumstances affecting the rate and spread of combustion is of equal importance to an understanding of the cause of the fire.

In the study of danger from fire, which must include safety to life as the prime consideration, there are two principle lines of investigation. The first one is Prevention, which is the elimination of possible causes of fire. The second is Protection, which is the limitation of the spread of fire. The study of these two phases requires the resources of the entire science of engineering. No single field can possibly encompass all the phases, for instance, found in manufacturing or mercantile operations. The Fire Protection Engineer is the liason officer, the catalyst, and an expeditor between the other engineering fields.

So let us accept the challenge and unite. Let us accelerate progress by removing all bars to speed and efficiency. Let us learn to understand each other, and in so doing bring about the defeat of Fire Waste. This will not be easy to do. But do it we must, or the curve will continue upward, an indictment of all engineers who are so far losing this battle by default.

Obituaries

Colonel Robert I. Randolph, who has been a member of the Western Society of Engineers since 1902, and a Life member since 1943, died in Santa Barbara, California, on October 18, 1951, the Society has just learned.

In 1921 and 1923, he contributed papers on Waterway Terminals at Society meetings. He was a Director of Operations for the "A Century of Progress Exhibition" in Chicago in 1933.

Colonel Randolph's father served as President of the Society in 1892-93.

Emory F. Hartzell, Life member of the Western Society of Engineers since 1940, died at his home in Louisville, Ohio, on November 27, 1952.

Mr. Hartzell had lived in Chicago 42 years. He was first employed by the Link-Belt Company; in later years by the Mead-Morrison Company.

Mr. Hartzell is survived by his widow, Nettie, and a nephew.

He joined the Society in 1909, and was enrolled in the Bridge and Structural, and the Mechanical Engineering sections.

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Nominating Committee Now Appointed

To the Corporate Members:

I am pleased to announce that in accordance with Article X, Section 3, of the Constitution, the Board of Direction has appointed a Nominating Committee as follows:

Donald N. Becker (Board Member)
Leroy F. Bernhard
E. Gordon Fox
V. O. McClurg
William E. Schweitzer
Ludwig Skog
Dick Van Gorp

The Constitution also provides that suggestions for nominees shall be solicited in the publications of the Society.

J. EARL HARRINGTON
Executive Secretary

Tear off and Return

To the Nominating Committee, WSE:

I suggest the following names for consideration by your commitee for offices indicated .

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WSE Applications

In accordance with the By-Laws of the Western Society of Engineers, the following names of applicants are being submitted to the Admissions committee for examination as to their qualifications for admission to membership into the Society in the various grades, i.e., Student, Associate, Member, Affiliate, etc. All applicants must meet the highest standards of character and professionalism in order to qualify for admissions, and each member of the Society should be alert to his responsibility to assist the Admissions committee in establishing that these standards are met. Any member of the Society, therefore, who has information relative to the qualifications or fitness of any of the applicants listed below, should inform the Secretary's office, 84 E. Randolph St., RAndolph 6—1736.

61-52 Edwin C. Edwards, Operating Engineer, Public Service Company of Northern Illinois, 477 S. Schuyler Av., Bradley, Ill.

62-52 Clifford I. Mock, Sales Engineering, Henry Pratt Co., 2222 S. Halsted St.

63-52 Gareld S. Reeder, District Operating Engineer, Public Service Company of Northern Illinois, Bradley, Ill.

64-52 Peary A. Zetterlund, Supervisor Branch Office, A. J. Boynton & Co., Dallas, Tex.

65-52 Ben Maccabee, Consulting Engineer & Director, Engineering Service Bureau, 7 S. Dearborn St.

66-52 Bernard G. Cunningham, Engineering Consultant, Sweet's Catalog — F. W. Dodge Corp., Merchandise Mart.

67-52 Lynn J. Riege, Engr., Materials Handling Equipment, U. S. Gypsum Co., 300 W. Adams St.

68-52 Sewall M. Osgood, Jr., Application Engineer, Westinghouse Electric Corp., Merchandise Mart.

69-52 William T. Horner, Project Engineer-Structural, Sargent and Lundy, 140 S. Dearborn St.

70-52 Warren F. Opitz, Assistant Engineer, Commonwealth Edison Co., 72 W. Adams St.

71-52 David W. Fentress, Vice President-Engineering, Flexonics Corp., Elgin, Ill.

72-52 John L. Nelson, Production Manager, Henry Pratt Co., 2222 S. Halsted St.

73-52 Gordon T. O'Neill; Manager, Chicago Office, Timber Engineering Co., 176 W. Adams St.

74-52 Dudley G. Sealy, Plant Engineer, Argonne National Laboratory, Lemont, Ill.

75-52 Arden G. Parry, Secretary of Corporation, Wm. E. Schweitzer & Co., 2207 Dodge Avenue, Evanston, Ill.

76-52 Herman D. Davis, Draftsman, Link-Belt Company, 301 W. Pershing Rd.

77-52 Joseph Dobias, Circuit Engineer, Automatic Electric Company, 1033 W. Van Buren St.

78-52 Frederick I. Wennerholm, Senior Partner, Vern E. Alden Co., 33 N. LaSalle St.

79-52 Michael A. Videka, Assistant Engineer, Argonne National Laboratory, P. O. Box 299, Lemont, Ill.

80-52 Frederick D. Logan, Partner, Genn & Logan, 3959 N. Lincoln Ave.

81-52 Donald J. Heath, Structural Designer, Link-Belt Co., 300 W. Pershing Rd.

82-52 James F. Heitert, Sales & Service Engineer, Moloney Electric Co., 100 W. Monroe St.

83-52 Harry M. Hills, Fire Prevention Engineer, Public Service Company of Northern Illinois, 72 W. Adams St.

84-52 Calvin N. Payne, Manager, Mid-West Div., American Meter Co., 122 S. Michigan Ave.

85-52 Gilbert N. Bryan, President, Geneva Construction Co., 111 Downer Pl., Aurora, Ill.

86-52 Abdon J. Brazaitis, Design Engineer, Henry Pratt Co., 2222 S. Halsted St.

87-52 Arthur T. Everham, President & General Mgr., Midwestern Contractors, Inc., Box 587, Wheaton, Ill.

88-52 Thomas O. Grisell, District Manager, American Steel Band Co., 221 N. LaSalle St. (Heidleburgh, Pittsburgh, Pa.)

89-52 Chester C. Burdick, Transportation Research Engr., Chicago Transit Authority, Merchandise Mart.

90-52 M. B. Grant, Central District Sales Mgr., Union Metal Manufacturing Co., 20 N. Wacker Dr.

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Any member of the Society may compete regardless of grade of membership.

Papers shall not be highly technical in nature. A clear, concise and interesting coverage is desired rather than complex formulae or derivations. The subject discussed should be of general interest to engineers but should not be of a political or highly controversial nature.

All members of the Society who wish to submit papers in this contest should contact the Secretary as early as possible and not later than February 1, 1953, and request a copy of the rules governing the competition and an outline of the minimum requirements for acceptance of papers. These cover in detail the mechanical make-up which should be followed in preparing and submitting papers for the contest.

Papers must be submitted to the Secretary for acceptance by April 1, 1953. If the Secretary finds that they meet the minimum requirements of the contest, he will forward them to the Awards Committee for review. The papers will be identified by number only. The Secretary of the Society is the only person who will maintain the key to the authors.

If any paper does not comply with such minimum requirements, the Secretary will so advise the author and discuss with him the points which are below the minimum requirements. The papers which are accepted will be forwarded to the Awards Committee for judging not later than May 1, 1953. Papers which have not met the minimum requirements by that time cannot be considered for prizes.

Papers which are accepted will be judged on originality of presentation, editorial merit and value to the engineering profession.

The papers submitted must not have been previously published in substantially the same form. No copyrighted materials shall be used unless permission has been obtained and so indicated. All manuscripts, drawings, etc., are to become the property of the Society and cannot be published without the consent of the Society.

If the papers submitted are NOT of sufficient merit to warrant the award of any or all of the prizes, the Awards Committee reserves the right to award less than the five established prizes or to postpone the competition.

The winners will be announced and the prizes presented at the annual meeting of the Society in June, 1953.

WSE Executive Secretary will furnish you with a complete set of rules and minimum requirements on request.

Mechanical Engineers End Show

Every going industry was included in the scope of the 20th National Exposition of Power and Mechanical Engineering, which was held in Grand Central Palace, New York, December 1 to 6 under the auspices of the American Society of Mechanical Engineers. The event coincided with the ASME annual meeting, and many of the exhibits at the show exemplified subjects under discussion by the engineers.

The exposition covered all branches of the field of power from the conversion of energy into fluid forms, such as heat, light, flowing water and steam, as well as hot, cold and compressed air, to its application in moving mechanisms. It included the conversion processes themselves, such as the combustion of fuels, generation of electricity and the operation of heat exchangers, pumps and blowers; distribution in transmission lines and pipelines, and it included all the many applications within the industrial plant, through wires, piping, shafting and belts, whether or not it generated its own power or got it from a public utility.

Attendance was limited to persons having a professional, scientific or personal interest in the exhibits. Visitors were admitted by invitation and registration, but without registration fee, while the general public was excluded.

Exhibitors numbering more than 300 occupied three floors of the Palace to the last available space. Many were specialists who confined themselves to a single type of product, though that might be shown in a range of sizes and patterns adapted to different applications. Others staged displays incorporating a dozen or more different associated products.

Major exhibit classifications included: Power plant equipment, power transmission equipment, electrical, heating and ventilating and air conditioning equipment; also materials handling equipment, safety, building construction, plant maintenance, and equipment for research and testing. The classified list included 350 items ranging from abrasives, acid resisting materials and accumulators, through boilers, condensers, drives, dryers and ducts to winches, woodworking machinery and wrenches.

Among the marvels of cooperative planning and execution which mechanical engineering has accomplished was equipment, now coming into use, that will make the largest and most modern power generating stations not only automatic, but responsive to load demand. Quite as remarkable in its way, and scaled down to quick comprehension by the Power Show visitor, was the automatic packaged boiler, as exemplified by several exhibitions at the Palace.

One fully integrated boiler of this class has a modulating burner control which automatically adjusts the rate of combustion to the load on the system, holding a constant operating pressure or temperature, according to whether the unit is producing steam or hot water. While the smaller units in the line use the on-and-off control common to small boilers in heating service, the larger units use a low-fire-start principle and operate continuously. Burners are designed for light or heavy oil, natural, mixed or manufactured gas, and combination gas-oil firing. The change over from oil to gas may be made in a matter of minutes.

Other noteworthy features of the same unit include automatic water level control for the feed water, with low-water cutoff and a boiler feed system including condensate tank and motorized feed pump. Safety features include a pressure-temperature switch to prevent operation above pre-set limits, electronic burner cutoff to guard against flame failure and a lockout control to shut off the burner in case of forced draft fan failure.

The self-contained automatic boiler on its own bed plate fits into a small space in almost any kind of building, generally requires no special stack, because forced-draft operation and design produce clean combustion, starts as soon as it has been connected and, practically speaking, takes care of itself from then on out. Such units have found a ready market in institutions such as hospitals and schools; in small plants such as bakers, bottlers, canners, dairies, dry cleaners and laundries. They also serve as stand-bys and auxiliaries in many larger manufacturing establishments.

Pacemakers in the advance toward automatic operation, which constitutes a marked and significent trend in mechanical engineering, are the manufacturers of control equipment, which is a projection from the instrument field. While basically instrumental, this movement represents a joint development in which the manufacturers of the controlled units are partners. It is highly spectacular in the newer power plants which are operated entirely from a single control room. It is highly economic in its application to processing equipment and even more so to machine tools which not only regulate performance to pre-determined levels, but occasionally even replace intricate calculations in so doing. Many innovations representative of this trend were found at the Power Show.

There was for example, the manufacturer of a famous line of electronic transmitters, which instantly communicate to the panel board information as to pressure, temperature, rate of flow and liquid level, and relay controller signals to remote switches and valves. To a long line of such specialties this manufacturer has added an electromatic pressure relief valve for boiler service that assures more accurately balanced operation at peak loads, more uniform pressure on the line, conserves power, decreases maintenance of spring-loaded safety valves and guards against overheating the super-heater.

Somewhat of a turnabout in customer thinking, as a result of the trend toward automaticity, was noted by a manufacturer of liquid meters, who pointed out that the belated recognition of the uses of metering is new in many industries. "People have thought of liquid meters for record purposes chiefly," said the sales manager, "whereas the more important function is that of control of liquid flow. Our exhibit stresses applications for control purposes."

"The first revolutionary line of motor controls since 1930, occupying one-half the space of conventional controls," was being offered by another exhibitor. For the variable speed regulation of fractional horsepower motors this new line employs a "patented principle."

A manufacturer of variable speed mechanical drives has just brought out a new model in sizes from 1/15 to 1/8 hp. This supplements the larger model in 1/4 to 1-1/2 hp, which was intro-

(Continued on Page 27)

(Continued from Page 25)

duced about a year and a half ago, but had not been demonstrated at any show or convention since its introduction. These two new units are designed to operate at lower input speeds than former models and without spring loading, affording cooler, quieter operation with increased efficiency and greater durability under the most severe continuous duty applications. Speed regulation is inbuilt and affords accurate speed holding, even under wide load variations. Inherent overload protection guards both the transmission and the driven machine from damage. In the event of a jam in the driven machine the transmission can be stalled for prolonged periods without injury.

Many kinds of equipment seen at the expositions are used throughout the mechanical world. Among the more common classes are pumps, blowers, valves and piping, power drives, motors and many others. Breadth of application, even within a single plant in just one industry, is typified by the experience of a manufacturer of heat exchanges, which supplied water heaters to a steel mill for continuous annealing lines, electrolytic tinning lines, cleaning lines, pickling lines and for precipitron cleaning.

A patented new type of proportioning pump control was seen at the Palace in association with a pump that is termed the lowest priced unit of its type and capacity on the market today. This unit comes in sizes from 10 cc to 180 gph. Another exhibitor showed a new development in elevator pumps which uses three pairs of gears within a manifolded housing to achieve compactness and quiet operation. Then there was, among many machines of the same class, a pump for handling pulverized coal.

Included in an exhibit representing a complete line of valves, fittings, steam specialties and fabricated piping for all power services was a new line of life-seal bonnet valves for 1500- and 2500-pound service. The bonnet joint is patented. A teflon-faced corrosion resisting plug, developed by another of the valve manufacturers further expands the field of application for its products in the chemical and process industries. A line of newly developed Teflon packing and gaskets for extreme chemical service was being offered at the same time by a well-known manufacturer in that field.

Then there was an exhibitor who has developed within the past year a wider variety of packless expansion joints, which require no maintenance; swing joint, universal joint, balanced joint and gimbal joint were among the styles displayed at the Palace. The flexible expansion joints offered by another exhibitor are fabricated from stainless steel, monel, and inconel to withstand operating pressures up to 5500 psi and temperatures from sub-zero to 1600F.

A well-known manufacturer of equipment for handling fluids displayed a recently designed self-supporting rotary pressure joint which is completely packless, self-lubricating, self-adjusting and self-aligning. It is built for application on rotary drying and cooling rolls in the paper, textile, rubber, plastics, chemical, and food industries. The paper industry uses joints of this description on paper machine dryers, calenders, corrugators, Yankee dryers and embossers. The textile industry uses such joints on can dryers, print cans, cotton slashers and embossers. The rubber and plastics industries use them on rubber mills and calenders, as well as on cooling rolls.

At another exhibit at the Palace a complete line of newly designed revolving joints was shown. These joints, which have been extensively tested, are made in 1/2-in. to 5-in. sizes. They require no lubrication or packing and are completely self-aligning when mounted with flexible hose. Still another manufacturer in the same field offered a new idea in swivel fittings, adapted to most loading arm installations. It eliminates the use of counter-balance arms, weights, cables and pulleys and is termed outstanding from the safety standpoint.

One large section of the show included exhibits dealing with the handling of gases. Equipment in this category embraced fans and blowers, with their drives and controls, ducts, screens, filters, scrubbers, and separators; as well as means of heat exchange for warming or cooling, according to any specific need. Innovations and improvements abounded in this group, as in others. For example, a new and smaller tube has been developed for a dust collecting system, the smaller size permitting the manufacture of smaller units. This means that this type of smoke eradicator can now be employed in plants where room is not available for more bulky equipment. This equipment was shown in operation, removing fly ash for re-firing and discharge. Another phase, air purification, was typified by a wet wash collector which functions entirely through the action set up by the exhauster. This equipment is used in boiler plants, foundries, chemical and food plants and others having to deal with contamination of the interior atmosphere by dust, corrosive fumes and even odors.

Another group of products dealt with water treatment, as instanced by an automatic zeolite water softener and a demineralizer which is said to be capable of delivering an effluent equal to, if not better than triple distilled water.

In the line of specialties was an exhibit dealing with the chemical cleaning of steam boilers and other heat exchange equipment. In reference to this method it was pointed out that chemical cleaning reaches to the bare metal in areas inaccessible to mechanical methods, avoids dismantling of equipment and is accomplished in a few hours, as compared with days or even weeks where other methods are used. An innovation of an entirely different kind is the new "powdered oil." This powder is used in a water solution as a cutting fluid in all types of machining operations. A companion product is used for grinding.

In the machine tool section of the show was a substantial group of exhibits featuring machines for the tool room, plant maintenance shop and also for manufacturing production. A three-spindle drill press turret head was one innovation. This self-contained unit gives wide freedom of set-up for long or short operations, for instance, in drilling, countersinking and tapping without changing tool points. Another exhibit, consisting of specially designed machine-tool attachments, featured a rotary table which, in effect, converts a drill press into a vertical miller.

Another featured innovation was a power tool with integrally motored unit that will saw, sand, grind, scratch-brush, buff, polish, drill, shape and plane. It will also drive a flexible shaft and through a power take-off it will drive other light shop equipment, such as a jig saw, lathe or air compressor.

The exposition was under the management of the International Exposition Co., with permanent headquarters in Grand Central Palace, New York. Charles F. Roth is manager and E. K. Stevens associate manager.

Art Institute On Campaign

The Centennial of Engineering held in Chicago last September made all of us aware of how wide a field of endeavor engineering covers. Every phase of modern life owes much to engineering—even our social customs and artistic expressions are affected by engineering developments—as witness the effect of transportation, communications, power, lighting and materials of constructions on our manners and habits. Obviously, the artistic expression of all people is vitally influenced by the physical, social and economic factors of their environment, and so is vitally affected by us as engineers. We should, therefore as engineers, take an active interest in such community activities as the Art Institute, that world renowned art museum, school and library in our midst. It should be pointed out that two men very well known to all engineers are intimately connected with the Art Institute: Ralph Budd, Honorary Chairman of the Board of Trustees and Avery Brundage, Member of the Board of Trustees.

The Art Institute, since its founding in 1879, has been supported entirely by private contributions. It has never made a public appeal for funds. Its facilities have always been available to the community as a whole, as a civic rather than a private venture.

At present, a large scale physical rehabilitation program is necessary: to provide a new heating system for the Institute (the present heating plant is twenty-nine years old); a new roof for the buildings; and to provide additional exhibition space. To raise funds for this purpose, a public campaign is being conducted. The goal is $1,600,000. All engineers are invited to support this project. Checks should be made out to the Art Institute Emergency Fund, and may be sent to the chairman of the Engineers' Committee, Eugene A. Dubin, 105 W. Monroe Street, Chicago 3, Illinois.

WSE Personals

Paul Rogers, formerly Structural Design Engineer with Sargent and Lundy, has entered into partnership with Howard J. Snitoff, Consulting Structural Engineer. The new firm's name is Rogers and Snitoff, Inc., Consulting Engineers. The firm is located at 510 North Dearborn street, Chicago 10, Illinois.

Snitoff has worked for many years for the U. S. Engineers, and Rogers has had many years of experience with numerous firms in Chicago. He has published numerous papers and a book, and won a WSE award in 1950 for his paper on "Power Plant Design."

James A. Stewart, who joined the Society in 1940, has been transferred to the Bell Telephone Laboratories, Inc., New York City. Previously, Stewart was with the Illinois Bell Telephone Company in Chicago.

Marie C. Folta is now Secretary to the Vice President of Chelsea Fan and Blower Company, Inc. Miss Folta became affiliated with the Western Society in 1950.

Oscar F. Magnus, who was formerly Research Engineer, American Brake Shoe Company, is now Assistant Chief Engineer, Ramapo Ajax Division of the American Brake Shoe Company. Magnus joined the Society in 1947. He is in the Mechanical Engineering section.

Rolland J. Strasser, formerly a partner in Sargent and Lundy, Engineers, has retired as of December 31, 1952. Strasser joined the Western Society in 1928, and was in the Mechanical Engineering section.

Edward R. Albert, formerly Engineering Manager of the Vern E. Alden Company, Chicago, is now Senior Partner and Engineering Manager of the company. Albert belongs to the Bridge and Structural section of the Society. He joined in 1940.

James W. Jardine is the new head of Chicago's water and sewer systems. He has been in municipal service for 44 years.

Chicago's newly formed Department of Water and Sewers, of which Jardine is the newly appointed commissioner, has over 3000 city employees.

One of Jardine's prompt actions after moving into a temporary office in City Hall was to have his engineers begin the design of a number of power eductors. These are huge vacuum cleaners that remove debris and dirt from sewer catch basins. Until now this cleaning has been done by hand methods.

The use of power eductors is not the only recommendation of the Little Hoover Commission which Jardine plans to put into effect. By his direction, specifications for power wenches to be used in routing out clogged drains are being drawn up.

Jardine became a member of WSE in 1936.

Coordinates Catalytic Research

Personnel and facilities for research on catalysts, the modern industrial version of the alchemist's touchstone, have been coordinated by Armour Research Foundation of Illinois Institute of Technology.

The new research team was set up in response to increasing industrial needs for such a service, according to William A. Casler, director of program development at the Foundation.

"We have conducted catalytic research previously for numerous industrial firms," Casler said, "but we want to strengthen this service further and make it available to an even wider section of industry."

Explaining catalysis, Casler said that in any chemical reaction where a substance alters the speed or the nature of the reaction without being changed itself, the phenomenon is known as catalysis and the substance is called catalyst.

"In practical terms," he added, "catalysts help industry by making desired chemical reactions occur more rapidly and produce higher yields of a purer product than they would without the catalyst." He listed the petroleum refining industry as a large user of catalysts in its operations.

The new research group calls for a team plan of action, with the team pooling the combined knowledge, experience, and research techniques of a staff capable in many related fields.

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American Bridge Gets Contract

Award of a contract to American Bridge Division of United States Steel Corp. for fabrication and erection of the steel framework of the Prudential Insurance Company's new mid-America home office in Chicago was announced January 7 by Carrol M. Shanks, Prudential's president. Approximately 31,000 tons of steel will be used in the new 41-story skyscraper—Chicago's first major office building in many years.

Officials of U. S. Steel stated that much of the steel will be fabricated by the Gary plant of American Bridge Division. American Bridge, which fabricates and erects bridges, buildings and many other steel structures from coast to coast, constructed the San Francisco-Oakland Bay Bridge, Empire State Building, Chrysler Building, United Nations' Headquarters and most of Rockefeller Center in New York. Its most recent job in Chicago has been the new Greyhound Bus Terminal at Randolph and Clark Streets.

Ground for Prudential's new building, which will rise over the suburban station of the Illinois Central Railroad and overlook Grant Park, was broken last August. Work has been going forward on the caissons and foundation on which the building will be erected. It is expected that this will require another eight months to complete.

Erection of the huge steel framework will probably begin the latter part of 1953, and engineers believe that it will take about a year to complete.

Naess and Murphy, Chicago architectural and engineering firm which designed the building, said the 600-foot structure should be ready for occupancy in 1955, barring contingencies. Charles Murphy, member of WSE, explained that the sinking of caissons and installing of foundation is much more intricate and difficult than in ordinary office buildings on an open site. The Prudential building will straddle 22 tracks of the IC, and work is being handicapped considerably by train movements.

The building will have about 1,000,000 square feet of rentable floor area. Of this the insurance company will use 30 per cent. The remainder will be leased, mostly to large corporations.

Among the features of the new structure, which will overlook Grant Park, will be an up and down escalator system from the train level through the seventh floor. A conveyor system of mail distribution for the company also will be installed.

Another outstanding feature will be 100 per cent air conditioning. A hall suitable for industrial exhibits and accommodating 1,000 will be situated on the ground floor. It will be available to both Prudential employees and tenants. Parking space for several hundred cars will be provided on three levels.

See The World The Engineer's Way

One sure way of seeing the world is to work for the army's corps of engineers.

Col. Robert P. Kline, district engineer for the Chicago district, announced recently the army engineers have openings for civilian workers in Alaska, Europe, Okinawa, Japan, French Morocco, Iceland, Greenland, Turkey and the Caribbean area.

Openings are for architects, engineers, draftsmen, engineering aides, administrative personnel, and mechanical trades for military construction jobs through the world.

Salaries range from $3,175 to $8,360 per annum, plus cost of living allowances of 10 to 25 per cent of base pay. Dependents are permitted to accompany workers in most areas.

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A New Year brings new hope, new plans, and a new outlook on life. Now is the time to start thinking of the engineering work you want to accomplish this year. If you need engineers, contact us and we may be able to help you. If you need a new position to challenge your engineering ability, get in touch with us. We are here to serve YOU.

B.H.A.

POSITIONS AVAILABLE

T-9513(a) JR. DESIGN DRAFTSMAN, ME Age: 21-30. Recent grads or better. Duties: drafting and design calculations to start and decreasing as more engrg. responsibilities are assigned in plant engrg. dept. of a meat packer. Salary: $80-$95 per week. Location: Wisconsin.

T-9513(b) ASSISTANT PURCHASING AGENT. Eng. degree. Age: 28-40. 2 plus yrs. exp. in production scheduling or inventory control. Know.: C.M.P. regulations desirable. Duties: assisting in supervising purchasing department on machinery equipment, and production supplies for a meat packer. Salary: $110-$120 per week. Loc.: Wisc.

T-9513(c) INDUSTRIAL ENG. Age: 28-35. 1 plus yrs. exp. time study work. Duties: establishing labor measurement standards from time studies and micro motion studies. Salary: $400 mo. Location: Chicago and Iowa.

R-9512(c) LAB. TECHNICIAN. Age: up to 40. 3 plus yrs. exp. in gas combustion equipment. Knowl: testing of appliances. Duties: testing gas appliances, doing some research and development. For a mfr. of gas appliances. Salary: $400-$500. Loc.: Chicago.

R-9512(d) QUALITY CONTROL. Age: up to 40. 3 plus yrs. exp. in inspection work on sheet metal products. Knowl.: shop processing and methods. Duties: supervising and actual inspection work on sheet metal products. For a mfr. of sheet metal products. Location: Chicago Salary: $400-$500.

R-9511 RECENT GRAD. ME or CE Duties: vibration testing of heavy machy. and blasting. Combination of field and office work. Office work consists of analysis of reports and records on vibration problems. Travel: 20% of time day or 2 at a time. Salary: $350. Loc: Chicago. Employer will negotiate the fee.

R-9510 SALES. Eng. Degree. Age: up to 40. Knowledge of boiler and machinery insurance, fire insurance and use occupancy or boiler or plant power machinery. Selling line of boiler and power plant insurance for old well-known company. Chicago, St. Louis, Minneapolis territory. Salary: $4000-$5000 and commission.

R-9507 CHIEF ENG. ME Degree or Equiv. Age: 35-50. 5 yrs. exp. Prefer man familiar with Oil field surface equip., product devel. and design. Must be able to "get along" with others. Duties: Chief Engr. over dept. of 8 engrs. and drafts. Resp. for policy formulation and complete supervision of dept. No traveling. For a foundry machine shop of Grey Iron Castings. Salary: $400-$600. Location: Ohio.

R-9506 FIELD ELECTRONIC ENG. EE or equiv. Age: 25-35. 1 plus yrs. in electronics, radar or microvaine work. Must be citizen. Knowl: general electronics and circuity. Duties: field engrg. installation, supervising repair and maintenance, application, modification of equip. For a mfr. of Commun. Salary: up to $500. Loc: as close to man's preference as possible. Some travel.

R-9505 TOOL DESIGNER & MACHINE. Age: up to 40. 5 plus yrs. exp. in designing special machinery, tool and dies. Duties: designing special equip. on the board. For a mfr. of machinery. Salary: $6000-$7200. Loc; Indiana. Employer will negotiate the fee.

R-9504 TOOL DESIGNER. Age: up to 45. 2 plus yrs. exp. in designing tools, dies, jigs, fixtures and production equipment. Duties: designing production equip. For a mfr. of Conveyors. Salary: up to $400 per mo. Location: Chicago. Employer will pay one half of the fee.

If placed in a position as a result of an Engineers Available or Position Available advertisement, applicants agree to pay the established placement fee. These rates are available on request and are sufficient to maintain an effective non-profit personnel service. A weekly bulletin of positions open is available to subscribers, Apply ESPS Chicago.

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PIPING DRAFTSMAN 65 plus. Many years drafting and detailing on piping, valves and fittings for process and power plants and refineries. Chicago $5000 532 MW.

DRAFTSMAN 41. Eight yrs. doing mechanical detailing and piping. Four years detailing parts. Chicago $5400. 535 MW.

PATENTS CE 30. Six and one half yrs. Structural Engr., doing design of concrete structures. U.S. $7200. 536 MW.

METALLURGIST MET 24. Two yrs. metallurgical observer in Open Hearth, scrap yard foreman & scrap inspector. Midwest $5200 537 MW.

SALES ENGR. 32. Six yrs. selling promotion, advertising, purchasing, supervise install. work, Chicago $6000 538 MW.

SALES ENGR. ME 40. One yr. designed 2 water coolers. Six yrs. sales engr. selling brand and cutting tools to industry. Two yrs. Chief Prod. Engr. in charge of processing, tooling and inspection. Midwest $7200 539 MW.

DEVELOPMENT ME 38. Seven yrs. development engr. responsible for selection, testing of Army field equipment. Midwest $6000 540 MW.

FIELD ENGR. CE 25. Two and one half yrs. supervision of layouts, lot surveys, purchasing, payroll, report writing and specification work. Chicago $4500 541 MW.

FIELD ENGR. CE 24. Seven mos. inspection and supervision of various construction and maintenance jobs. Midwest $4500 542 MW.

DESIGNER ME 34. Four yrs. eight mos. design engr. in process and chemical plants. One yr. four mos. instrument man on erection and layout of jigs and fixtures for aircraft production. $6500 Outside Chicago. 543 MW.

FIELD ENGR. CE 25. Twenty-three mos. Jr. Designer doing preliminary and final design on reinforced concrete, estimating, hydrologic and hydraulic studies and some specification work. Chicago $4200 544 MW.

Reviews of Technical Books

Fixed End Moments

Tables and Formulas for Fixed End Moments, by Paul Rogers, Frederick Ungar Publishing Co., New York, N. Y. 1953. 95 pages. Price $3.75.

This is a time-saving, helpful book which furnishes the fixed end moments for practically all possible loading conditions, eliminating the solution of any formulas. Designers, who use the MOMENT DISTRIBUTION METHOD, often find that actual loadings require time-consuming computations for the FIXED END MOMENTS.

The book contains loading diagrams, mathematical formulas and tables & charts of fixed end moment coefficients.

The jacket of the book mentions that the author, a Chicago consulting engineer and educator, won a 1950 W.S.E. award for his paper on Power Plant Design.

P.R., W.S.E.

Voltmeters

Vacuum-tube Voltmeters, by John F. Rider, revised by John F. Rider and Alfred W. Barber, John F. Rider Publishers, Inc., New York 13, N.Y. Second edition, 1951. 422 pages. $4.50.

This is the only book we know of which devotes itself exclusively to vacuum-tube voltmeters. And this edition is twice as large as the 1941 edition. This second edition covers all types of vacuum-tube voltmeters, including diode, triode, rectifier-amplifier, tuner, amplifier-rectifier, and slide back.

Step-by-step methods of applying the vacuum-tube voltmeter (VTVM) to basic measurement of capacitance, inductance, resistance, a-f, r-f, and d-c voltages and currents are given in the section on the applications of VTVM's.

This book has both its practical and theoretical sides, which makes it especially valuable to not only engineers, but also to laboratory workers and technicians. Further, it is a good source for experiments to be used in laboratory courses. There are review questions at the end of each chapter which increase the book's worth for use in courses.

Vacuum-tube Voltmeters has a large number of schematic diagrams, graphs, and illustrations. A bibliography containing over 200 references gives engineers a source of published articles on VTVM.

Jet Powerplants

Aircraft Jet Powerplants, by Franklin P. Durham, Prentice-Hall, Inc., New York, N.Y. 1951. 326 pages. $6.65.

This book places its emphasis on the gas turbine. It is written mainly for use in undergraduate courses, with fluid mechanics and elementary thermodynamics as prerequisites. Probably, this book is best suited for junior or senior courses in jet powerplants.

The first six chapters of the book have been organized to form the basis of a short study of the over-all phases of jet propulsion and the principles of the gas turbine. The next few chapters take up the study of jet engine components in more detail. The last two chapters present the fundamentals of the ramjet engine and the rocket motor.

The theory of compressible gas flow is developed, as necessary, throughout the book.

Many graphs, illustrations, and diagrams appear in the book; also many formulas. At the back is a ten-page table on the "Thermodynamic Properties of Air."

Architectural Graphics

Architectural Graphics, by C. Leslie Martin, The Macmillan Company, New York 11, N.Y. 1952. Paper bound. 213 pages. $4.00.

Several sentences from the author's preface aptly tell why a book of this sort is useful:

"It is difficult or impossible to explain design and construction satisfactorily in written or spoken words alone. Shapes, sizes, and design relations require drawings for their clear explanation. In order to translate creations of the mind into terms which can be most clearly understood by clients, and into instructions which can be most easily followed by builders, it is necessary that architects and designers be thoroughly familiar with all methods of representing objects by drawings." The book shows how to gain this familiarity.

Architectural Graphics serves the further purpose of bringing together all materials related to the drafting methods used in architecture, and by extension, many phases of engineering. Previously, until a recent trend set in, most of these materials were treated in separate courses. In this book, even multi-view orthographic drawing, the kind all engineers know, is taken up briefly.

The three main sections of the book are "Orthographic and Oblique Drawing," "Perspective Drawing," and "Shades and Shadows."

There are any number of drawings and sketches demonstrating the ideas presented by the text. They also demonstrate the book's principle that words used by the designer are more meaningful when augmented by drawings.

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Northwestern U Dedicates Hall

Formal dedication of McGaw Memorial hall combined with the traditional Founders' Day Convocation will be held at Northwestern University at 3 p.m. on Sunday, Jan. 18.

Some 5,000 persons are expected to attend the ceremonies which will feature the Hon. Charles P. Taft as speaker.

A 250-voice choral group will sing at the dedication of the building which will be the site of the World Council of Churches meeting in 1954.

Others on the program include Rabbi Louis L. Mann of the Chicago Sinai Congregation, the Rev. Fr. Leo Hartke of the St. Athanasius church, Evanston, and Harold A. Smith, Chicago attorney who is president of the Northwestern Alumni association.

Invited guests include the mayors and presidents of North Shore communities, prominent church and civic leaders, and the more than 300 alumni and friends of the University whose gifts made erection of the $1,300,000 auditorium possible.

McGaw Memorial hall, which can be arranged to accommodate 12,000 persons, will be the largest auditorium north of Chicago's loop and is to be used for civic events, convocations and commencements as well as indoor athletic events.

The building is named in honor of the late Rev. Francis A. McGaw, missionary to Africa, whose son, Foster G. McGaw, gave $400,000 toward the building fund.

Charles P. Taft, speaker for the dedication and convocation, is a prominent church lay leader, a former president of the Federal Council of Churches of Christ in America, owner and publisher of the Cincinnati *Times-Star* and Republican candidate for governor of Ohio last year.

He has held a number of important federal posts including director, U. S. Community War Services, Federal Security Agency; director, Wartime Economic Affairs, U. S. Department of State; and director, Transport and Communications Policy.

Double Recoil Used on Cannon

According to the Army, the tremendous "kick" of its new atomic cannon is absorbed by an innovation in artillery —two recoil motions. The primary recoil takes care of the big gun's actual "kick," while the secondary recoil absorbs the forces created by the primary, says R. Hoe & Company, Inc., New York City, maker of the unusual mechanism.

In recoil, the atomic cannon's entire carriage slides back on stainless steel guides over its central turntable and rear pan. The gun is returned to normal position by a hydro-pneumatic device connected to the carriage.

Another feature of the 280 mm weapon is the ease with which its giant barrel can be raised and depressed—zero to 55 degrees. This is achieved by a hydro-pneumatic equilabrator. It so balances the barrel that in the event of a power failure one man can operate the mechanism by hand without exerting more than 30 pounds of force on a control wheel, say Army ordnance authorities.

A prime manufacturing problem was precision machining of metal parts weighing up to 1600 pounds. For instance, a surface mirror finish of four micro inches was required. In one case this was accomplished with a honing machine that was intended originally to finish cylinders of much smaller diameter than those used in the super gun's recoil and equilabrator mechanisms. The machine was rebuilt to accommodate larger work. Extensive alterations also were made on other machine tools, because urgency required the use of existing production equipment.

One of the many intricate manufacturing problems solved was machining a soft copper ring over one foot in diameter and only one-quarter inch in cross section. The part was finished to a parallelness accuracy of one-half thousandth inch. Still another production achievement was machining a finished part weighing 250 pounds from a 1200-pound steel block.

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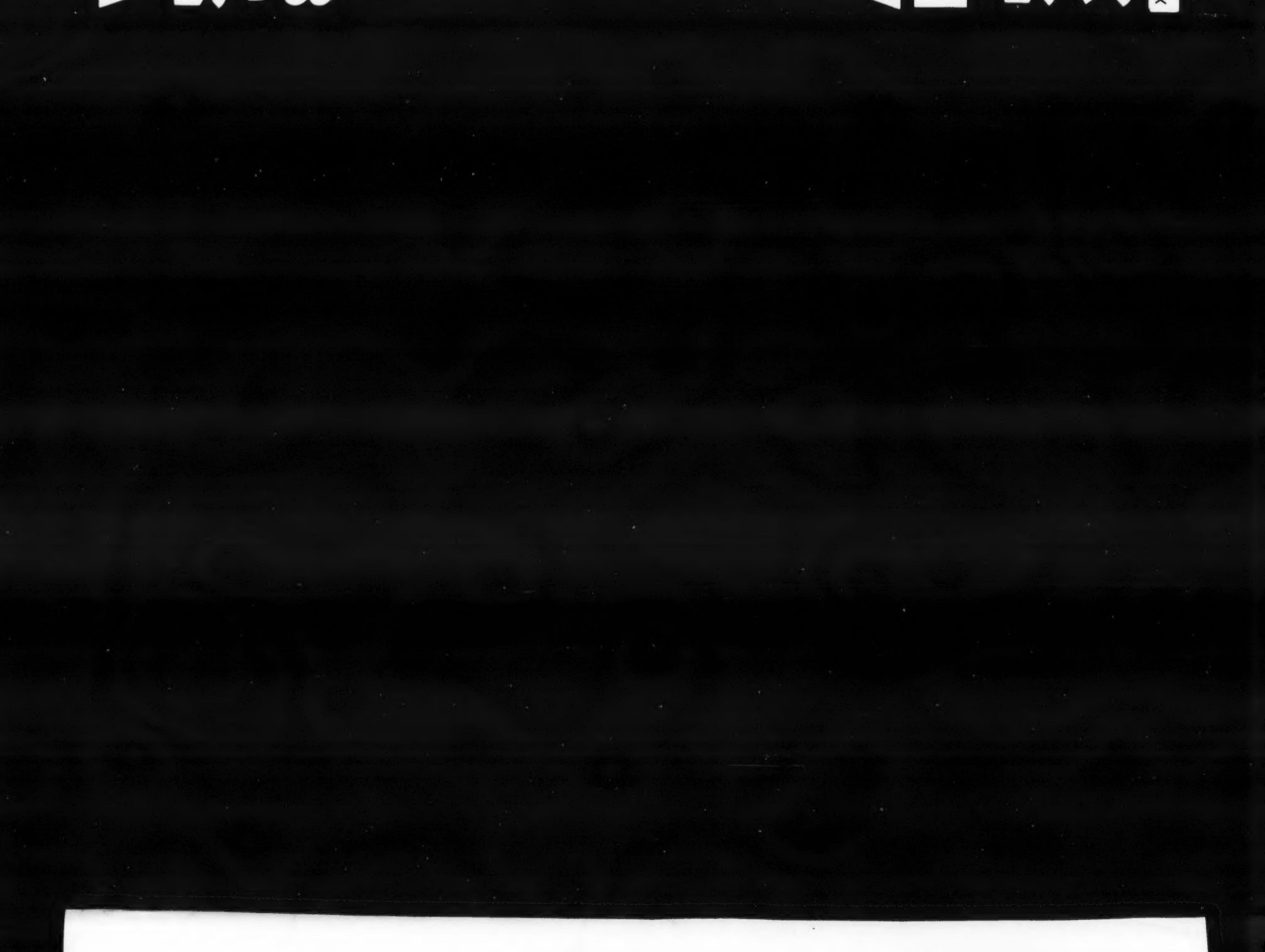
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